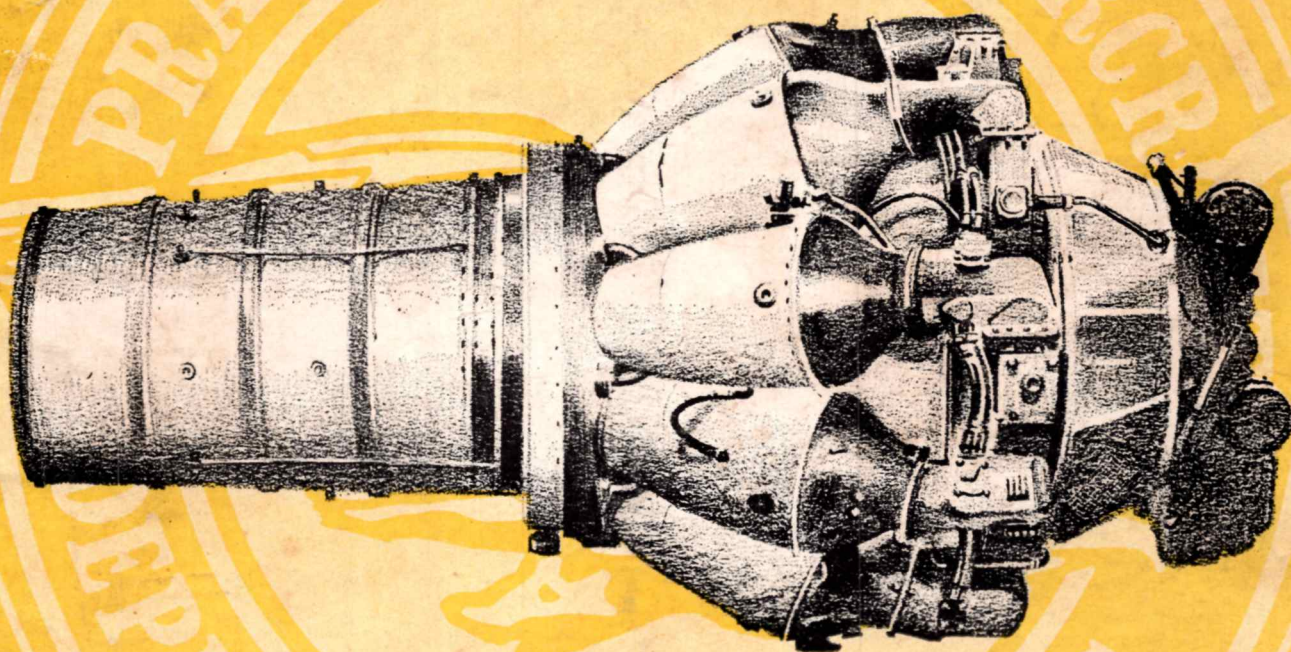


America's Premier Aeronautical Magazine

AERO DIGEST

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AVIATION ENGINEERING

JANUARY, 1949 50 CENTS



TURBO-WASP

for the Navy's Grumman Panther

First turbojet to carry the famous Pratt & Whitney seal of dependable power, the J-42 Turbo-Wasp engine has now passed its official Navy type test. Soon you'll be seeing the Grumman F9F, Navy's new shipboard fighter, streaking overhead with the tremendous thrust of this great new engine.

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ONE OF THE FOUR DIVISIONS OF UNITED AIRCRAFT CORPORATION

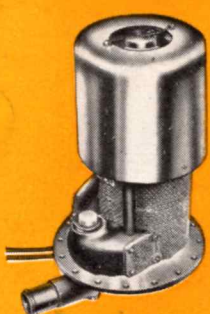
About our AIRCRAFT ACCESSORIES Division

THE PRODUCTS illustrated on this page are typical of a wide range of precision units manufactured by the Aircraft Accessories Division of our company at "Tapco"

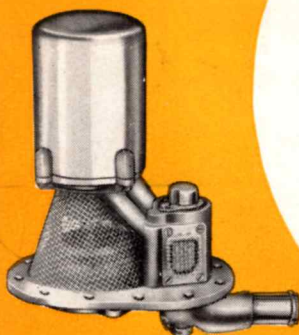
This division has specialized for years in the engineering and production of fuel systems for jet and piston-engine military planes, as well as commercial and personal aircraft of all types. It also designs and has unexcelled equipment for the production of the intricate compressor assemblies of steel, aluminum or magnesium, used for supercharging aircraft engines.

It is the largest peacetime manufacturer of these highly specialized products, and was the largest during the war.

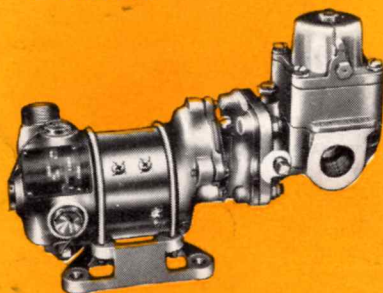
We invite engine and plane builders and commercial airline operators to use the development, testing and production facilities of our Aircraft Accessories Division.



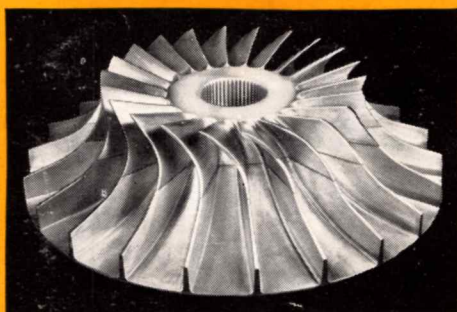
Submerged Centrifugal Type Fuel Booster Pump for Jet Aircraft.



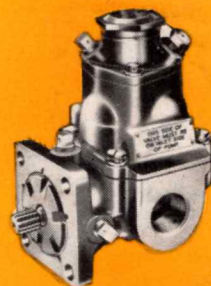
Submerged Centrifugal Type Fuel Booster Pump.



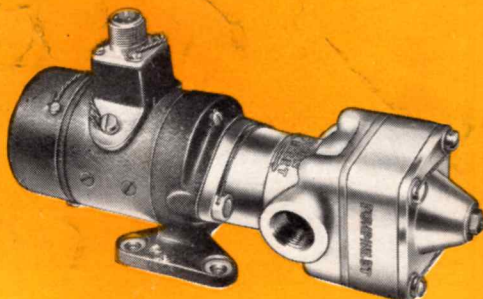
Electric Motor-Driven Fuel or Water Injection Pump.



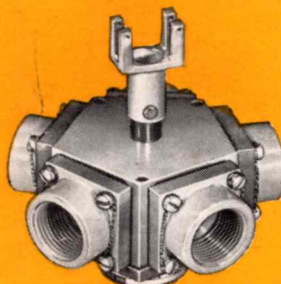
Inducer-Impeller Assembly—Wright Cyclone 18 (R-3350)



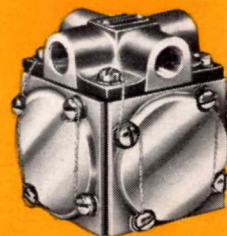
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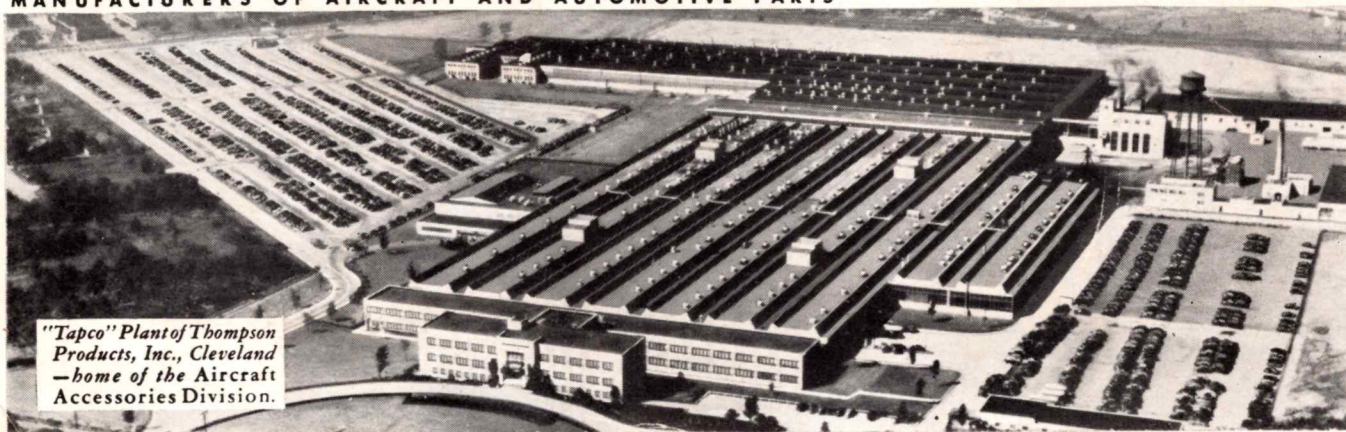
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Keeps ice from choking a jet's throat

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To B. F. Goodrich engineers, this looked like a problem for electrically heated rubber—thin, tough rubber with a core of resistance wires. They designed an electric rubber lining for the jet's diffuser cowl, in the "throat" that funnels air to the combustion chamber (see picture above).

The resistance wires were precisely arranged to concentrate heat where it

was most needed. A thermostatic control was added. Then, with electric rubber supplying the heat, the diffuser cowl was put through a series of rugged icing tests. No ice formed!

Diffuser cowls lined with B. F. Goodrich electric rubber are now in use on a new production model jet bomber.

B. F. Goodrich electric rubber is the most efficient way of getting the right amount of anti-icing heat to the right spot. It simplifies design, saves weight. It is very flexible and fits curved surfaces tightly and smoothly. And it requires little power to operate.

Besides diffuser cowls, B. F. Goodrich electric rubber has done a successful anti-icing job on propellers, control surfaces, spinner domes, air scoops, antenna and pitot masts, hydraulic lines, water tanks and many other airplane parts. It is a typical development of the B. F. Goodrich research that supplies aviation with effective answers to its tough problems. *The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.*

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to Make Aviation History*



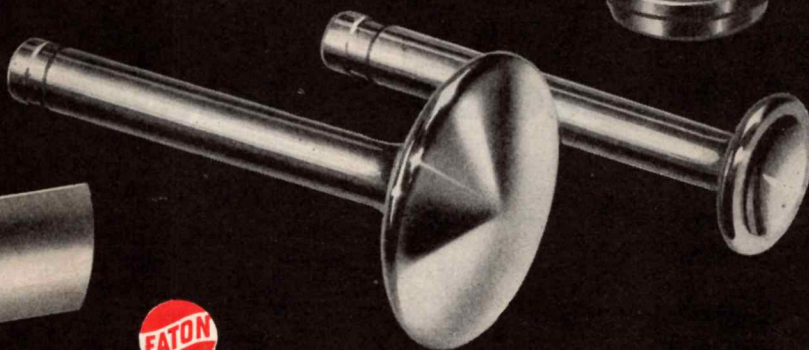
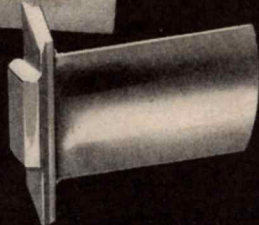
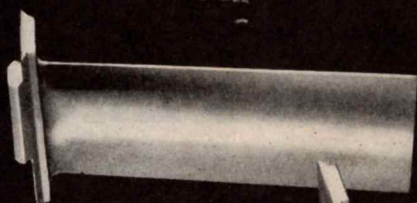
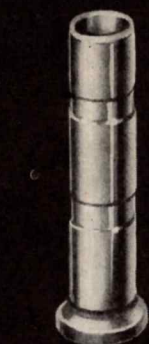
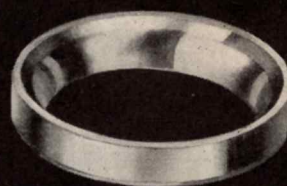
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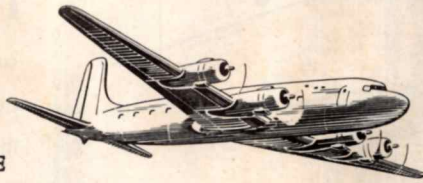
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VOL. 58

ESTABLISHED 1922

No. 1

Aero Digest Weekly
LETTER TO AIRMEN
KENDALL K. HOYT, Editor

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of the Americas
HOWARD MINGOS, Editor

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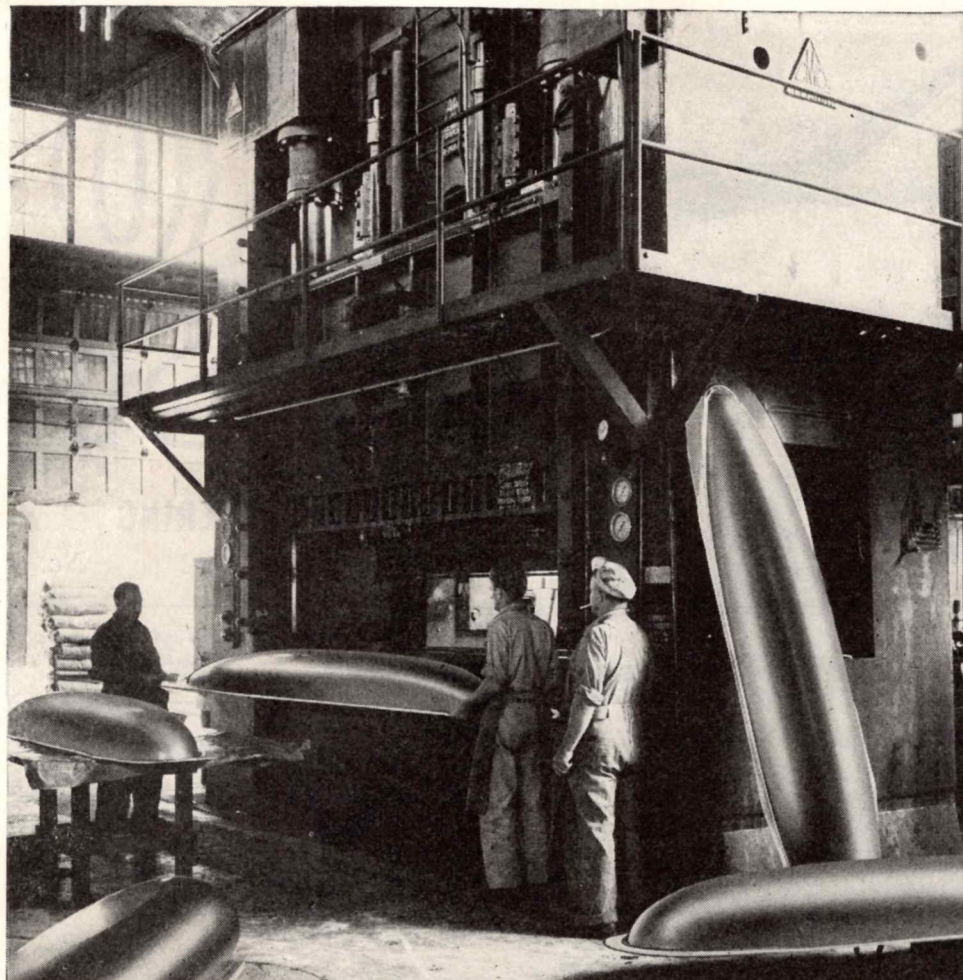
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JANUARY 1949 — Volume 58, Number 1. Published monthly by the Aeronautical Digest Publishing Corporation, 515 Madison Ave., New York 22, N. Y. (PLaza 3-6969). Cable AERODIG, New York, N. Y. Printed in the U. S. A. Single copy, 50c. Subscription: U. S., Spain, Central and South America, \$5 three years, \$4

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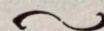
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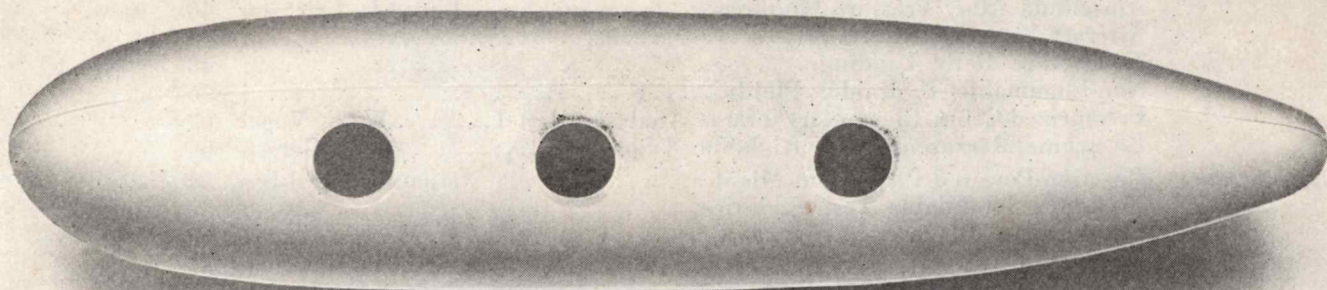


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EDITORIAL

What This Country Needs—

MR. PRESIDENT, if you want to hold your military budget to 15 billion, get a Secretary of Defense who will have guts enough to act on the requirements of the nation to assure its national security. Forget the Forrestal balanced-force idea under which the Army, Navy and Air Force share the appropriations as co-equals and any increase or decrease in one must be matched by the other two.

Air Power is the nation's first line of defense and as such should receive as much of the 15 billion as is necessary to make it 100% efficient. With Air Power assured, there will be very little chance of World War III.

It is about time to retire the "Mutual Admiration Society" that has existed among the "Higher Ups" in the Army and Navy for generations and give some thought to the country's defense needs as well as the taxpayers' ability to support them.



Unification Hooley

WE ARE getting sick and tired of spending hours every day wading through Washington's Armed Services press releases containing 90% hokum and hooley. It is about time that the assorted Secretaries quit horsing around and get down to the many serious problems now facing them under the Unification Act.

Eliminate this fantastic waste of time, money and energy trying to sell their selfish ideas. And realize that propaganda cannot cover up the truth, which is that fighting among the Services is more acute today than it was before the passing of the Act—despite Secretary Forrestal's recent *Saturday Evening Post* story that everything was "lovey dovey" in the Pentagon. Bunk, just plain bunk.

Unify the public relations, press information and such other departments, that are passing out these phony press releases. Place it in the hands of a competent, non-prejudiced civilian head and you will soon find these Service bickerings at an end.

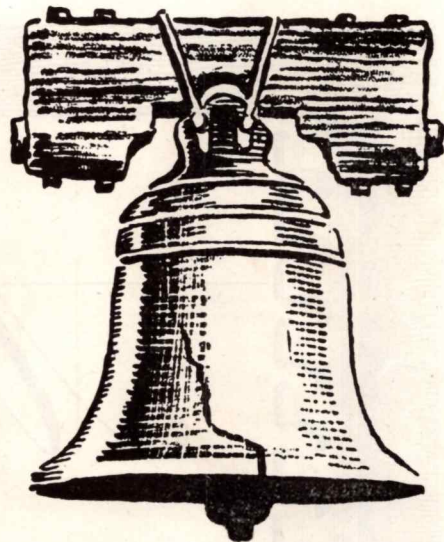


Aviation Progress

THE establishment by the Daniel and Florence Guggenheim Foundation of two national centers of rocket and jet propulsion, one at Princeton University in the East, the other at the California Institute of Technology in the West, is an outstanding event in American aviation.

History does repeat itself.

In the year 1925, aeronautical education was at a low ebb in this country, as was all of aviation. Congress had abandoned military and naval aviation, manufacturers built less than a dozen commercial planes



during the year, and at our Colleges and Universities instruction in aeronautics was hardly thought of.

It is folly to think that everything of national interest must come from the Federal Government. In the spring of 1925, Harry F. Guggenheim, keenly interested in aviation, sat in on a committee of New York University to consider plans for establishing a school of aeronautics at this institution. His father Daniel was shown a letter outlining the plan and, as a result, the Daniel Guggenheim School of Aeronautics was founded at New York University. This was followed by the Daniel Guggenheim Fund for the Promotion of Aeronautics, which established schools or laboratories of aeronautics at California Institute of Technology and elsewhere.

When the Guggenheims, father and son, had the vision and courage to enter this unpopular field, they rendered a tremendous service to our country. World War II was won in the air. It was won in a large measure because we had better aircraft. One reason why we had better aircraft was that the Guggenheim Schools gave us better engineers.

Now unfortunately, after two wars to end all wars, we again stand at a critical moment in our history. Again the need is there for supremacy in the air and supremacy now means not airplanes with reciprocating engines, but curious aircraft of extraordinary shapes, flying at supersonic speeds, propelled by jet and rocket motors. The complexities of such devices are beyond imagination.

To conquer these problems appropriations in themselves will not do. The primary need is brains, and young brains at that. Harry F. Guggenheim,

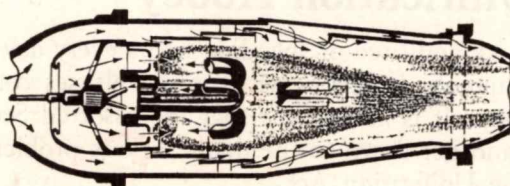
(Continued from page 70)

No 5

Mamba

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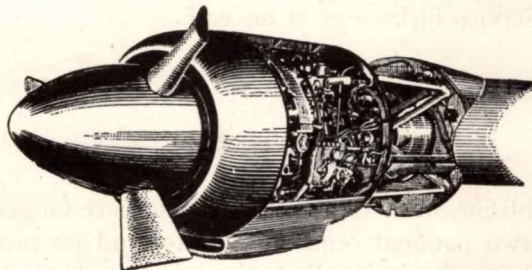


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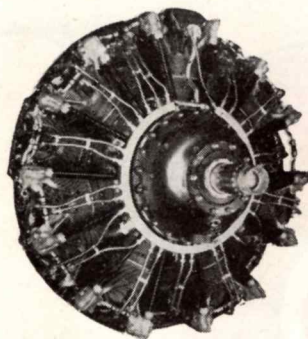
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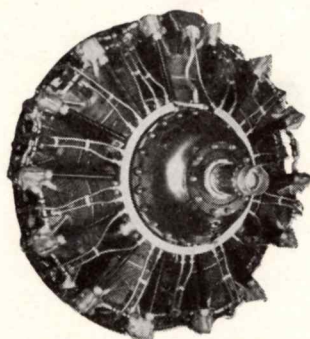




R1830-92

150

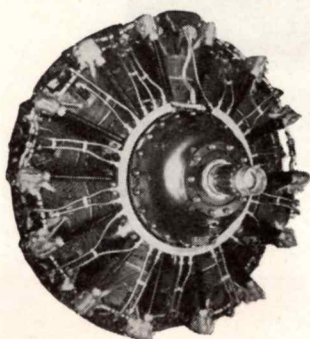
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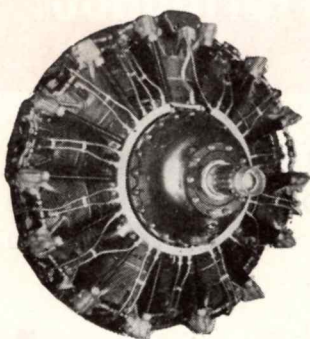


R1830-43-65

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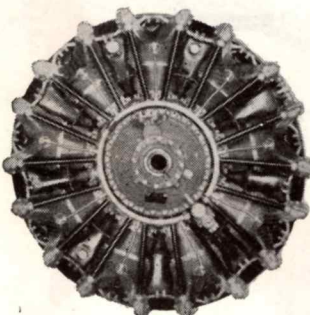
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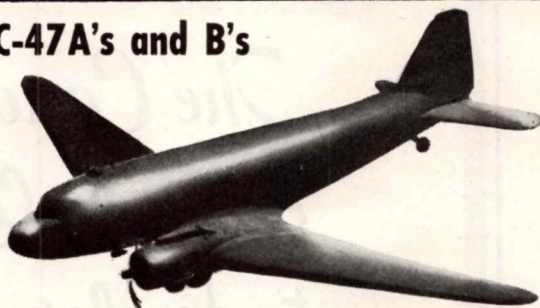
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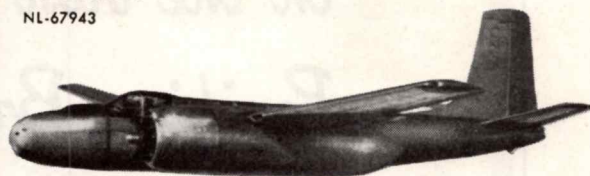
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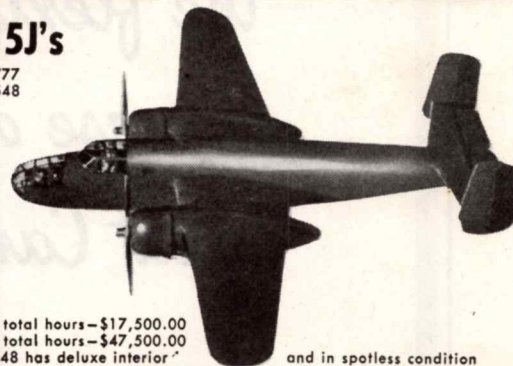
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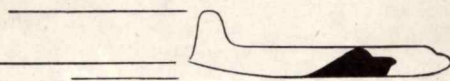
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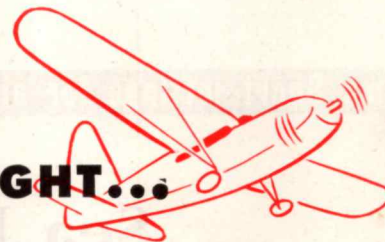
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IGNITION CABLE**

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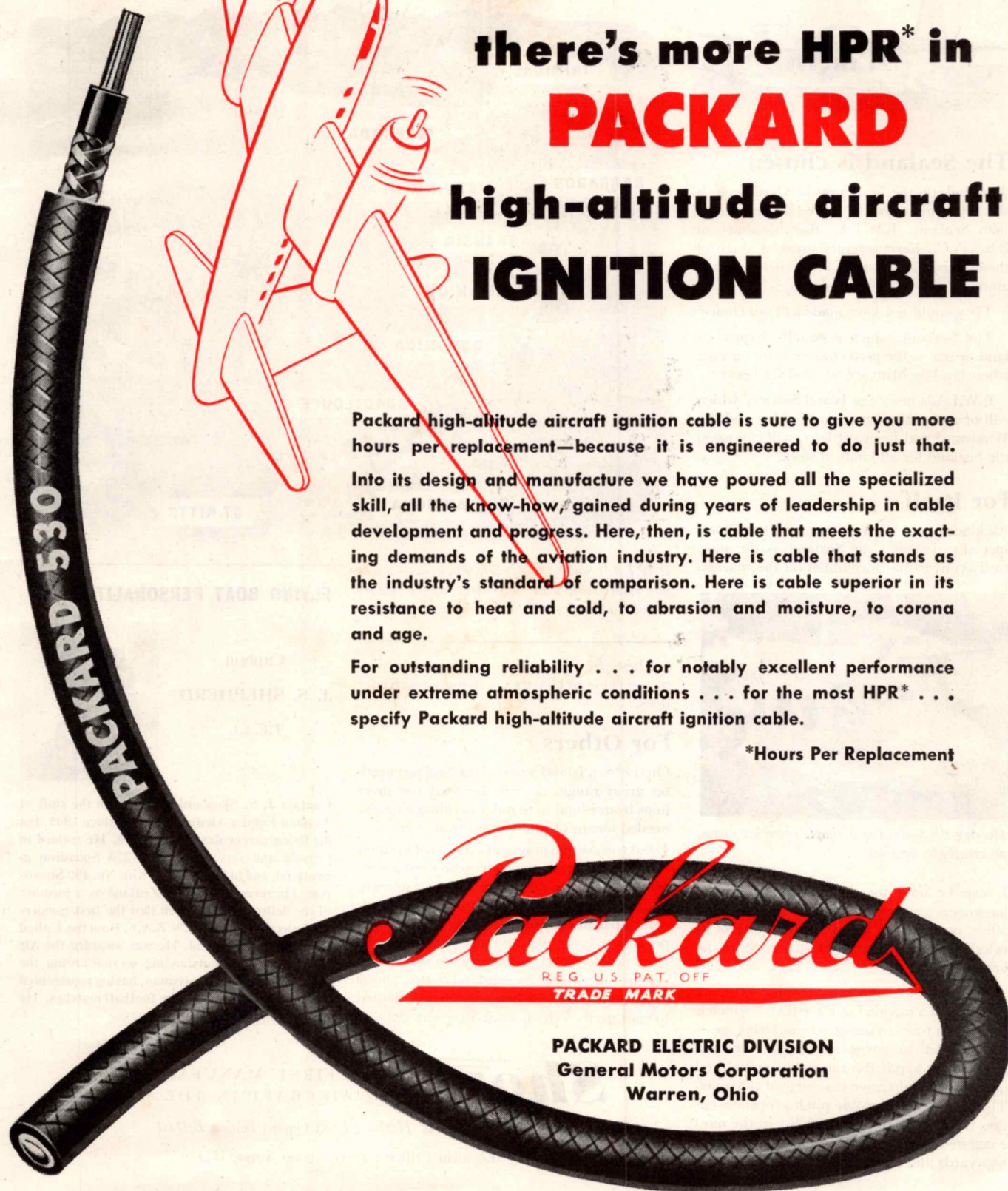
Into its design and manufacture we have poured all the specialized skill, all the know-how, gained during years of leadership in cable development and progress. Here, then, is cable that meets the exacting demands of the aviation industry. Here is cable that stands as the industry's standard of comparison. Here is cable superior in its resistance to heat and cold, to abrasion and moisture, to corona and age.

For outstanding reliability . . . for notably excellent performance under extreme atmospheric conditions . . . for the most HPR* . . . specify Packard high-altitude aircraft ignition cable.

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TRADE MARK

**PACKARD ELECTRIC DIVISION
General Motors Corporation
Warren, Ohio**



Some Short jottings for airline operators, charter companies, and V.I.P.s

Sea Island Service



The Sealand is chosen

Trinidad, on the border of the Caribbean, is the key to new territory served by the amphibian Sealand. B.W.I.A., the subsidiary of B.S.A.A.C., have recently ordered three of these versatile aircraft for general duties among the West Indian Islands.

They could not have made a better choice.

The Sealand, which is equally happy on land or sea, is the perfect aircraft for an area where landing strips are few and far between.

B.W.I.A.'s new 'Sea Island Service,' which will operate daily between Trinidad and the Windward and Leeward Isles, will call upon the Sealand for all kinds of work.

For Itself

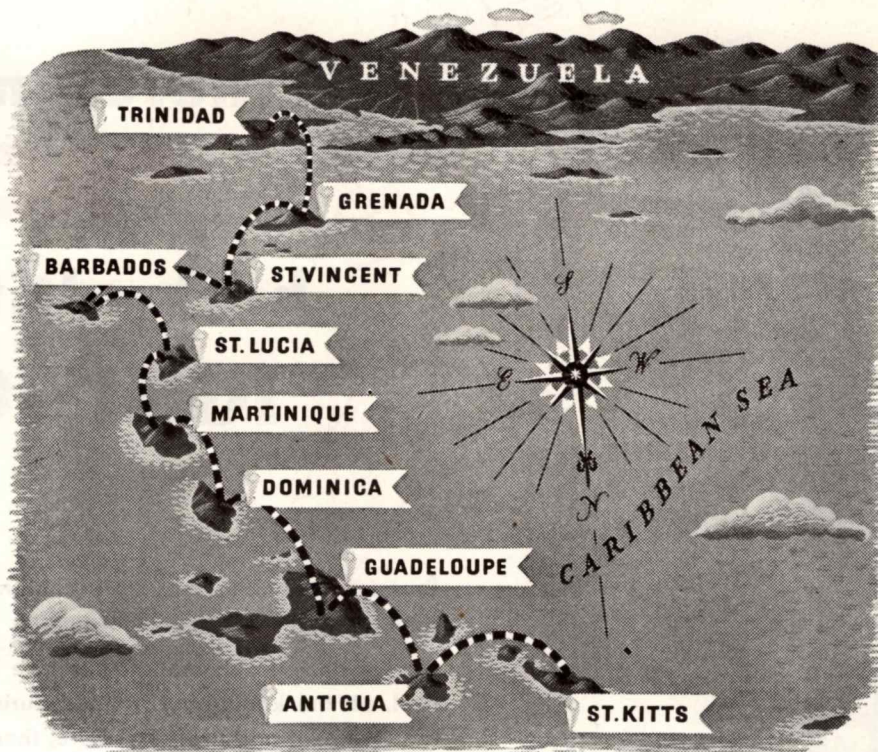
All kinds of work? Yes, because Shorts have specially designed the Sealand as the most easily convertible amphibian on the market.



Mooring the Sealand is a simple operation carried out entirely by the pilot.

It can be used for the rapid transport of passengers or freight, as a luxurious flying office, or as an air ambulance. In any of its roles it will give the greatest service at the lowest cost.

The Sealand's range is elastic. With 54 gallons and a payload of 1,400 lbs. — which is equivalent to seven passengers and baggage — the Sealand can cover nearly 350 miles at a speed of 150 m.p.h. But 120 gallons of fuel, and 994 lbs. of freight, give it a range of 765 miles. The Sealand's reversible pitch propellers endow it with high manoeuvrability in the most congested waterways. It has a take-off run of 550 yards and climbs at 880 ft. per minute.



B.W.I.A.'s Sealands will operate twice-weekly over this main route, with 'flag-stops' at the smaller islands. Dominica and St. Vincent are sea-dromes.

These are only a few reasons for its immense value to charter companies and feeder lines.

For Others

On the 'Sea Island Service' the Sealand needs no great range. It will be used for short hops from island to island, providing a much-needed means of inter-island transport.

But consider its practical value to plantation owners and estate-managers who need a general 'hold-all' to take them and their stores to outlying districts. In this case, the Sealand, with a petrol consumption of 6 ground miles per gallon, is the answer to many of the executive's problems. If you have scattered estates, not easily accessible by overland routes, Shorts are confident that the Sealand can be adapted to your needs. Why not ask Shorts for details?

FLYING BOAT PERSONALITIES

Captain

J. S. SHEPHERD

T.E.A.L

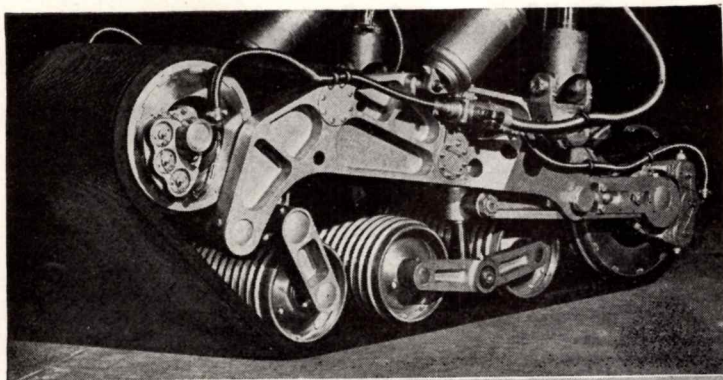


Captain J. S. Shepherd has been on the staff of Tasman Empire Airways Limited since 1945, but his flying career dates from 1939. He trained in Canada and served with No. 228 Squadron in Scotland, and in West Africa with No. 490 Squadron. He returned to New Zealand as a member of the delivery flight which flew the first Sunderland aircraft for the R.N.Z.A.F. from the United Kingdom to Auckland. He was awarded the Air Force Cross for outstanding service during the War. He is a keen sportsman, having represented Otago in provincial Rugby football matches. He is also a sprinter of some note.

Shorts THE FIRST MANUFACTURERS OF AIRCRAFT IN THE WORLD

Short Brothers & Harland Ltd., Queens Island, Belfast

London Office: 17 Grosvenor Street, W.1



The new track-type landing gear that provides a "built-in-runway" for the Fairchild C-82 Packet shown below.



Electrol builds the Air Springs for the "Built-in-Runway" of the C-82 Packet

THANKS to its revolutionary, track-type landing gear, the Fairchild C-82 Packet can take-off and land where it chooses—on sod, sand, or other unimproved surfaces.

Credit for this outstanding advancement — that enables aircraft to carry their own landing strips — is shared in part by Electrol engineers. Applying their wide and diversified hydraulic knowledge, they designed and built the Air Springs, which provide the tremendous force necessary to maintain tension in the built-in-runway's "belt"—yet, keep it flexible enough so it will deflect when field obstacles are encountered.

This is but one of many examples where Electrol was called upon to help solve a problem involving the use of hydraulics.

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And today's airline passenger enjoys a smoother, faster, safer, more comfortable trip because of developments of such companies as Sperry. Sperry has developed, engineered and flight-tested the instruments that help the airlines

maintain schedule reliability in all weathers . . . help build public confidence in commercial flying.

Sperry aeronautical products in use today on many airlines include the A-12 Gyropilot*, for smooth, level flight . . . the Automatic Approach Control, for landings in all kinds of weather . . . the Gyrosyn* Compass and other flight instruments giving accurate information on position and direction . . . the Engine Analyzer that detects, locates and identifies engine irregularities in flight, saving valuable time on the ground.

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"—it seems that the bomber of World War II is not a match for large numbers of defensive fighters and that the answer to enemy interceptors is not the bomber alone, but also its escorting fighters."

CY CALDWELL

DURING the past year there has emerged a new American concept of war. It is new because for the first time in our history we are preparing for a war in the air, with the forces of the land and the sea playing supporting roles. Also, we realize that we cannot count on European allies to sustain alone the burden of war on the ground until our industry has had time to convert into war production. If war starts, we must be ready to act at once.

In three months or even in weeks after the first blow, a Russian Army may have rolled over Western Europe. The coasts of northern France, of Belgium and Holland then may be used as launching sites for guided missiles of even greater destructive power and range than the German V-2. If that occurs, then England becomes a target for missiles against which there appears to be only one defense—to deny an enemy the use of launching sites.

This can be done only by means of

an army on the ground: not only the comparatively small and ill-equipped armies of France, Belgium and Holland, but also strong fully mechanized expeditionary forces from Britain and the U.S., supported by powerful tactical air forces. Part of our strategic air forces must be diverted to purely tactical missions—the slowing down and hampering of an advancing army by blasting its lines of communication. Hence, if the first move of the Russians is to seize rocket-launching sites to bombard Britain and knock her out of the war in the shortest possible time, it would appear that the new American strategic concept of airpower must be made sufficiently elastic to cover such an eventuality.

Alaska the Vulnerable

Another possibility at war's outbreak is the surprise seizure of our air bases in Alaska and the Aleutians. Russian bombing alone on those bases would hamper our operations, but would af-

ford no direct help to Russian bombing of the United States unless the bases themselves were seized. Recalling the air invasion of Crete and the magnitude of our present air lift to Berlin, it does not require the imagination of an air strategist to conceive of a mass air attack from Siberia by several hundred Russian bombers and fighters, accompanied by a Russian airborne army to land by parachute or in gliders. Against the small forces we now have based in Alaska, the operation, if carried out in force, should succeed within a period of hours.

Thus, it would appear a sound policy to prepare now to resist on the ground and in the air; in Europe, in Alaska, and anywhere else where one of our outlying air bases might be seized in a surprise attack. Although defense never yet has won a war, failure to take adequate defensive measures could result in such losses, and in such enemy gains, of positional advantage that we

could not mass our strength to take the offensive. In the Battle of Britain the Royal Air Force at first fought on the defensive—and thus saved England to stage an offensive later.

The defensive and the offensive are equally important parts of war. A boxer who seeks to win only by a knockout punch—the offensive—may be floored by his opponent before he throws that punch unless he has protected himself against the blows of his adversary. He combines defense and offense, in the proportions he deems necessary to win victory. Air forces and armies must use a similar strategy.

Heart of the Offensive

The heavy bomber is the striking weapon around which our entire structure of the air offensive is built. In a sense, it occupies the position in an air force that a battleship used to occupy in an old-fashioned navy, and which the carrier has supplanted in our modern air navy. Like the battleship, the big bomber carries the heaviest punch. But, also like the battleship and the carrier, it requires the protection of other fighting craft.

Air-power exponents usually write about strategic bombing as though the big bomber was capable of going anywhere within its radius of action unescorted by defending craft. In an article published in *Life*, General Carl Spaatz writes confidently about our Air Force's ability to reach the vulnerable industrial system of Russia.

"Take a globe," he says, "and a string scaled to 2,000 miles. Pin one end down at Moscow and swing the free end westward. It will take in the British Isles and part of Iceland. Swing it south and it will take in part of North Africa. Now do the same thing from the Urals, fixing one end of the string on Magnitogorsk and swinging the other south. The free end in its sweep will take in Iraq, Iran and Pakistan as far south as Karachi. From the Ukraine-Volga center the string will pass through Britain, France and North Africa. From Baku in the Caucasus the sweep will encompass part of India, Saudi Arabia and part of Europe. There is additionally in Siberia a fast-growing center of industry, not to mention the double-track Trans-Siberian railroad. This region could be reached by B-29's from bases in Japan.

"The controlling factor now is the radius of the B-29," Spaatz states, "which with post-war improvements is more than 2,000 miles." He makes no mention of escorting fighters.

Writing on high sub-sonic speeds for air warfare in the authoritative *Air University Quarterly Review*, an official Air Force publication, Colonel Bruce K.

Holloway (General Chennault's wartime fighter commander) says: "The present conception of fighter escort is due for a considerable revaluation within the next several years. The single-seat fighter which meets established speed and range requirements, and which depends on its speed and maneuverability to engage in effective combat with enemy interceptors, has about reached its limit of marginal utility."

He discusses human limits of fatigue of the fighter pilot in the past war and assumes that, if we are not able to maintain bases within a thousand miles of our future strategic targets, the human fatigue problem of the single-seat, subsonic, ground-based escort fighter is large. He doesn't believe that we can possibly incorporate more than 2,000 miles range into the design of a fighter which can cope with enemy interceptors by offensive action, and suggests fighter towing, fighter refueling, and parasite fighters (air-based—that is, carried in large ships) to increase range.

Colonel Holloway says: "It is believed that the forthcoming period of high-speed subsonic flight offers a great opportunity for the strategic bomber. . . . Against such a bomber, a subsonic interceptor would have little chance of success." He concludes: "The indiscriminating limit presently imposed by

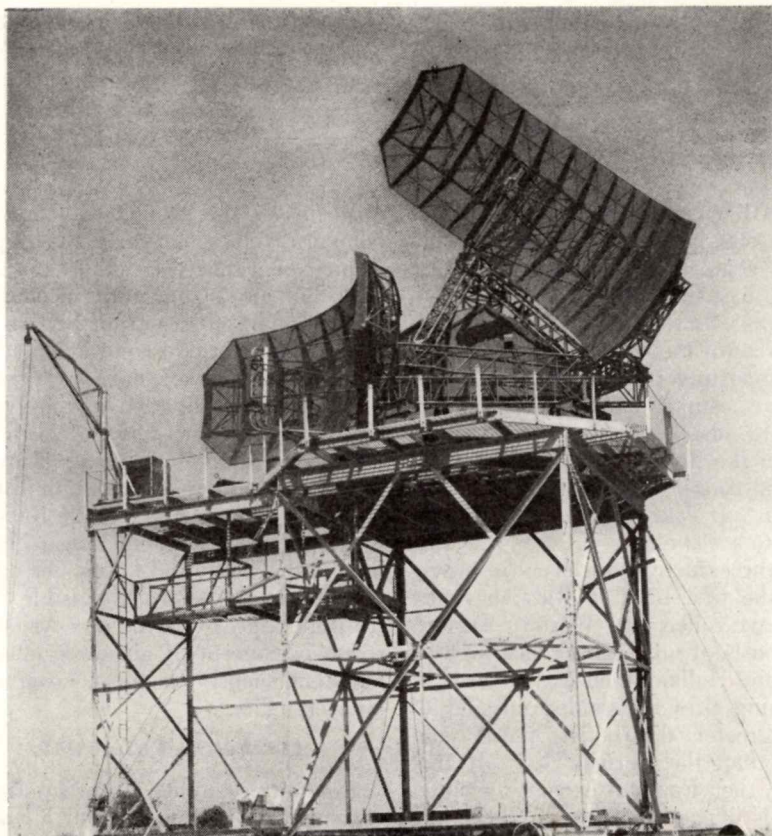
the speed of sound reduces the effectiveness of the escort fighter and enhances the position of the high-speed strategic bomber. We must build our bombers to operate in the immediate vicinity of sonic speed, or they will probably have great difficulty in reaching future targets."

Hangover Bombers

The bombers that we have in quantity are those left over from the last war. They are incapable of flying anywhere near the "immediate vicinity of sonic speed." And jet interceptors—both our own and Russia's—are climbing rapidly into that vicinity. So it seems that General Spaatz's piece of string, with which he confidently measures distances of 2,000 miles into the heart of Russia, is not a reliable instrument with which to measure the radius of action of *successful* bombing raids in any war of the immediate future—say during the next year. A distance of 2,000 miles is a long hop, during which numerous interceptors might reasonably be expected to make effective contact with the bomber.

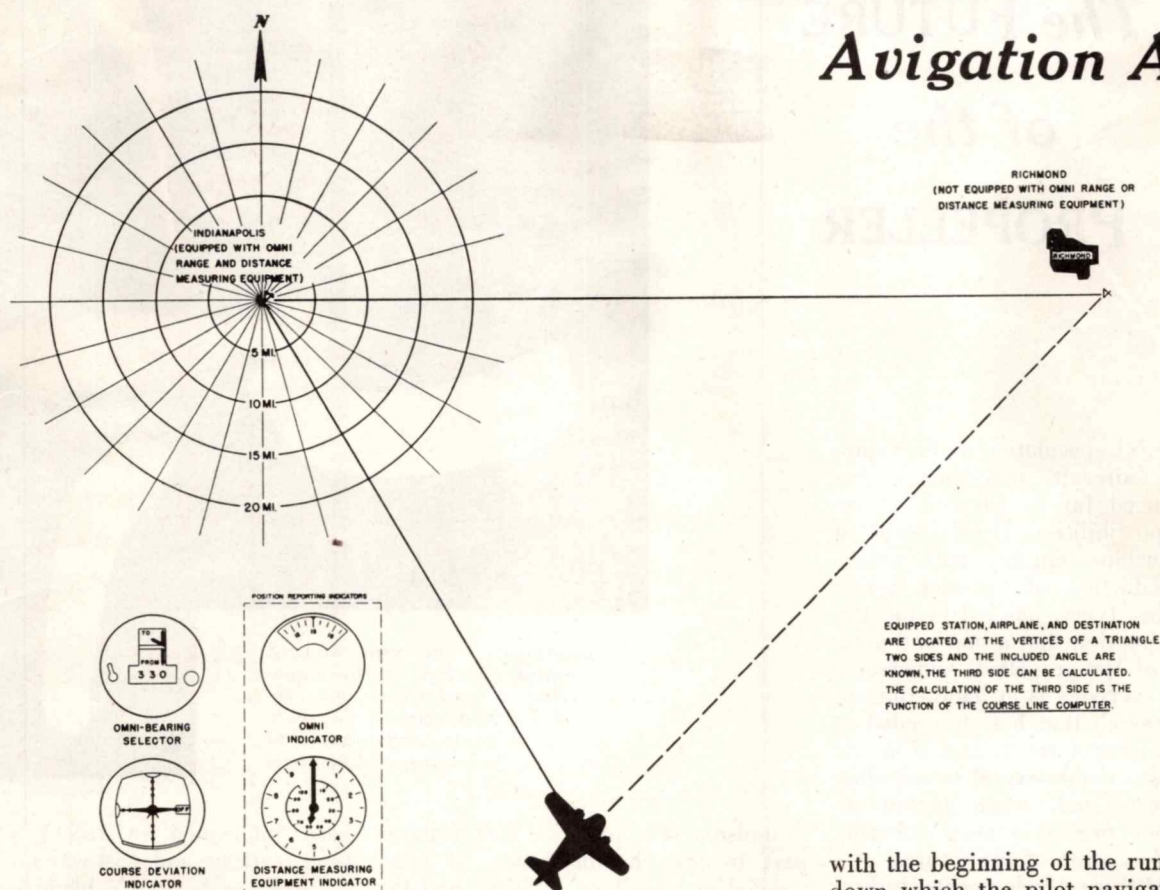
Although surprise in war always will be possible, it does not seem probable that Russia would risk a war of counter-bombardment until it has the atomic bomb. But there is no way of learning,

(Continued on page 94)



In the pre-radar days the advantage lay with the bomber. Now the defending fighter is directed to the approaching aggressor via radio

Transitional Avigation Aids



The course-line computer solves the unknown side of the triangle and permits flight on a straight course, even if tangential to the omnirange beams

J. H. DELLINGER, Chairman of the Radio Technical Commission for Aeronautics, in welcoming Government and industry officials and the aviation press to a demonstration of air traffic-control systems at the CAA Experimental Station, Indianapolis, stated that the first stages of a 15-year program designed to make all-weather flight a reality are in progress.

He admitted that a 15-year program is highly unusual these days, but hastened to add that the plan is fixed in direction only and that the door is wide open for full adoption of the best that science, invention and industrial efficiency can bring up.

The RTCA demonstration put emphasis upon the "transition system." Here are capsule descriptions of the elements of air traffic control and navigation which are to be completed and in operation within the next five years.

Omnirange.—Omnirange is being installed throughout the country. It operates on VHF, making it free of static and permits pilots to navigate by watching a vertical needle instead of

listening to wearying sound signals. Omnirange offers an almost infinite number of courses, provides guidance in every compass direction.

Distance Measuring Equipment (DME).—When used with omnirange, DME gives the pilot a continuous fix at all times. When tuned to a station, a single dial will tell him how many miles he is away from it; taking of cross bearings will no longer be necessary.

Course-Line Computer.—With this highly desirable computer the pilot is enabled to fly a straight-line course some distance away from the omnirange, instead of zig-zagging from one omnirange to another. The computer is an electronic brain which continuously solves navigational triangles, using omnirange and DME data, plus course information preset into the computer by the pilot.

Instrument Landing System (ILS).—ILS is now installed at major airports. It is a radio highway directly to the runway with the proper glide path for contact

with the beginning of the runway and down which the pilot navigates for a safe landing during periods of low visibility. A cross-pointer instrument in the cockpit indicates any deviation from the ILS beam. Two or more ground transmitters (outer and middle markers), spaced at known distances from the airport, indicate to the pilot how far he is away from the runway during his approach.

Precision Beam Radar (GCA).—In ground-controlled approach radar UHF radio pulses are fired into the approach area and, when the pulses strike an airplane, they are reflected back to a scope on the ground. The pips on the scope indicate the position and direction of the approaching plane, enabling the ground controller, through voice radio, to guide the pilot down to a safe landing in bad weather.

Surveillance Radar.—With surveillance radar ground controllers receive a continuous picture of all aircraft in the vicinity of ranges varying from 30 to 100 miles. An ingenious Moving Target Indicator (MTI) can be applied to reflect only moving planes on the screen—no stationary objects. Most were developed for military use.

Lightweight Receivers.—A pressing problem is the development of light omnirange receivers and related equipment
(Continued on page 92)

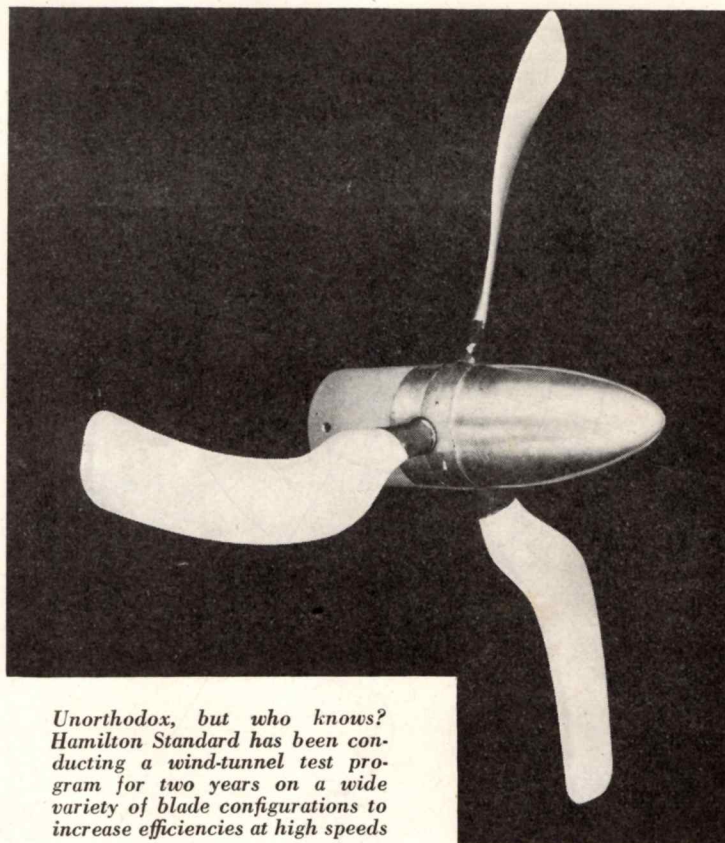
The FUTURE of the PROPELLER

RECENT speculation on the future of aircraft powerplants has ranged far in advance of immediate possibilities. Development of the gas-turbine engine, with subsequent production of turbojet fighter and bomber types, has led to the frequent assumption that a new and golden age of jet-propelled, supersonic flight for everyone is at hand. But out of the research that has proceeded at a feverish pace since the end of World War II have come several outstanding developments and, when pieced together, they present a more sobering picture of aviation of the future.

Some of these developments, radical in nature, will probably be the forerunners of aircraft and components to be seen late in the next decade or so. Others have been improvements upon existing equipment and designs that permit the retention of aircraft components whose worth has been proved in the past.

One of the most important results of these developments is the revival of interest in the propeller, generated by the realization that the pure jet engine is not the be-all and end-all of aircraft

Editor's Note.—This article represents the composite opinion of Hamilton Standard Propellers Div., United Aircraft Corp. The material was assembled for AERO DIGEST by E. Russell Trotman of the company's Public Relations Department.



Unorthodox, but who knows? Hamilton Standard has been conducting a wind-tunnel test program for two years on a wide variety of blade configurations to increase efficiencies at high speeds

propulsion. The propeller has a major part to play in the future of commercial and military aviation, and the piston engine still has a long life expectancy.

Recent developments in both the propeller and piston engine have strengthened their position, especially in view of the shortcomings of jet installations for certain aircraft types.

Propeller engineers have always been concerned with the effects of high-speed compressibility on propeller-blade airfoils, particularly in the region of the tip, where speeds of more than 600 mph have been common during the past 15 to 20 years. Hamilton Standard designs have reflected the changes required to assure efficient blade operation as airplane speeds increased, and activity in this field has

been intensified in recent years to meet wartime and post-war needs.

In the early 1930's blade tips were pointed and consequently relatively thick. Continuing research showed that blade tips should have a smaller ratio of thickness to width to reduce losses as air speeds increased, and should be wider to provide for the absorption of increased horsepowers in the smallest diameter. For the past year, most of the blade designs installed on new transports have been of the square-tipped type (AERO DIGEST, May, 1946), built of dural or hollow steel.

Parallel Problems

Fundamentally, the problems of the high-speed propeller are identical with those of the high-speed wing. They are based on the continuing effort to secure the lowest possible thickness ratio of the airfoil without the sacrifice of structural soundness. It is notable that the thickness ratio of blades has been cut in half by research carried on within the past three years. Further improvements will depend upon the ingenuity of the propeller designer and the amount of concentrated design study placed on the problem.

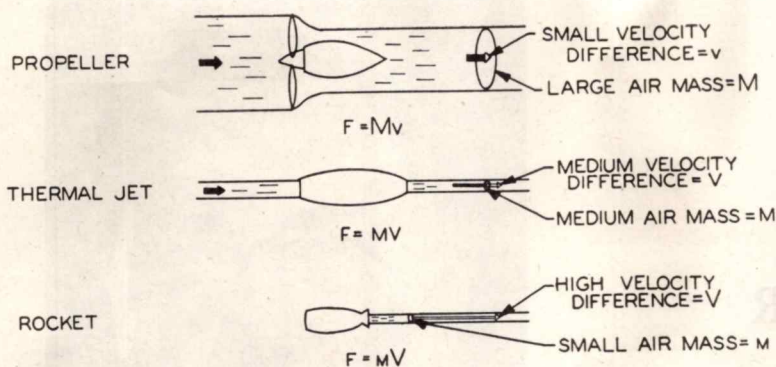
Development of the thinner, wider tip has made it possible for the blades to operate efficiently at higher air speeds before the appearance of the efficiency losses that accompany compressibility shock. Thus, propellers of the newer designs are operating ef-

The Future of the Propeller

"Actually, the Air Force has a very urgent requirement for the turboprop and for reciprocating aircraft engines as well as for turboprop engines, despite implication to the contrary." . . . Gen. Hoyt S. Vandenberg, Chief of Staff, USAF.

"The turboprop engine promises greatly increased efficiency for long-range bombardment aircraft . . . the Air Force is now obtaining propeller research and design data on high-speed aircraft." . . . Gen. Carl A. Spaatz, USAF Chief of Staff, Retired.

" . . . my advice to airline companies is to prepare to operate aircraft with propeller gas turbines almost at once. . . ." Sir Frank Whittle.



The propeller moves an enormous mass of air at low velocity for thrust; the short-lived rocket contains its air which is expelled at a terrific velocity; the jet fits between the two

ficiently at 500 mph and subsequent refinement will soon increase this figure by approximately 100 mph more. Since this has been such a recent development, it has not been generally appreciated.

In evaluating the ability of the propeller to give high efficiencies at high speeds, Hamilton Standard has been conducting a wind-tunnel test program for two years on a wide variety of blade configurations, both orthodox and unorthodox. From this program, the conclusion has been reached that refinement of the wide, thin, straight blade best reconciles the conflicting requirements of the propeller's aerodynamic and structural features.

The Efficient Propeller

The propeller has a fundamental advantage as a propulsive device in that its slow movement of a large mass of air, gas or water, where "slip" is small, is far more efficient and less wasteful of energy than the jet's, or rocket's rapid movement of a small mass, where "slip" is large. This slip represents wasted power.

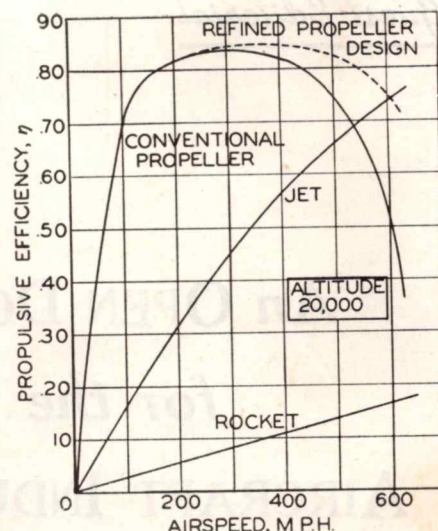
The size of the mass of air to be moved by the turbojet is limited by the capacity of its gas-turbine unit. If this same unit were designed for a propeller drive, the required propeller would be several times larger in diameter and would consequently move a much larger mass of air per unit of time. Since there is no powerplant-inflicted limitation on the size of the propeller, it is possible to select the most efficient size within the aircraft's special limitations.

The slipstream speed of the turbojet must be considerably higher to produce comparable thrust. The situation is aggravated by the fact that the slipstream speed of the turbojet is essentially constant at all flight speeds, whereas the propeller's slipstream speed varies with airplane speed to maintain a more favorable ratio be-

tween the two. Only at the higher speeds, where the difference between the slipstream and aircraft velocities diminishes, does the turbojet approach the efficiency of the propeller.

Propeller development during the past three years has kept pace with engine and airframe developments. Changes in the propeller's mechanism have provided faster, even more reliable pitch-changing operation, its structure has been lightened and strengthened, and its blades have been revised to meet the requirements of high speeds and increased power.

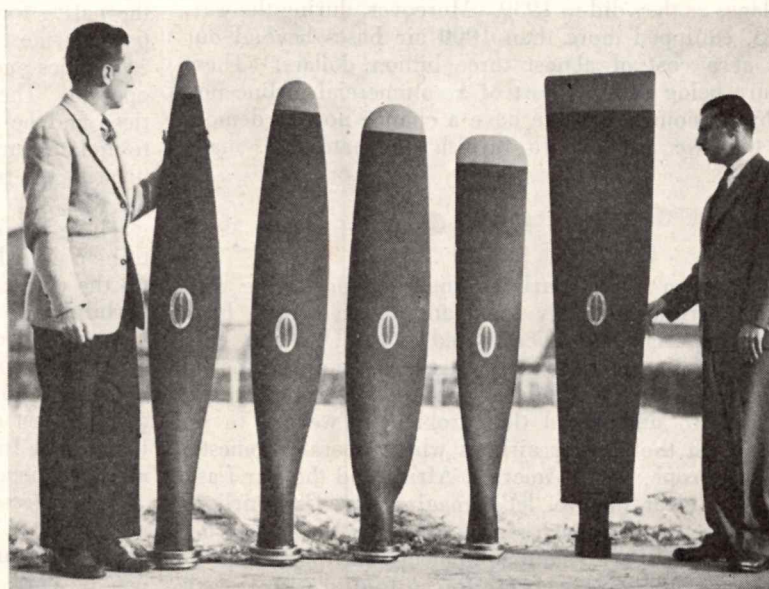
These changes have been the outward manifestation of several new elements of operation, all of which posed their own particular problems and required extensive development work to perfect or solve. New propeller functions include reverse thrust, automatic synchronization and electric de-icing, all of which are now in regular use on the newer airline transports.



New design could maintain a high thrust efficiency into the subsonic region

Typical of the nature of these new problems is the first propeller-order vibration stress, commonly designated as "IP," which developed to significant proportions in the past two years as the result of higher airplane speeds, greater propeller diameters and more efficient aircraft structures. One P stress results from a periodic variation of the air loads acting on each blade during each revolution due to angularity of air flow with respect to the thrust axis of the propeller. Angularity of air flow can occur in two ways, the first due to airplane incidence, the second caused by a nacelle tilt which has been "built-in" to meet airplane-stability requirements.

This type of stress excitation, which
(Continued on page 85)

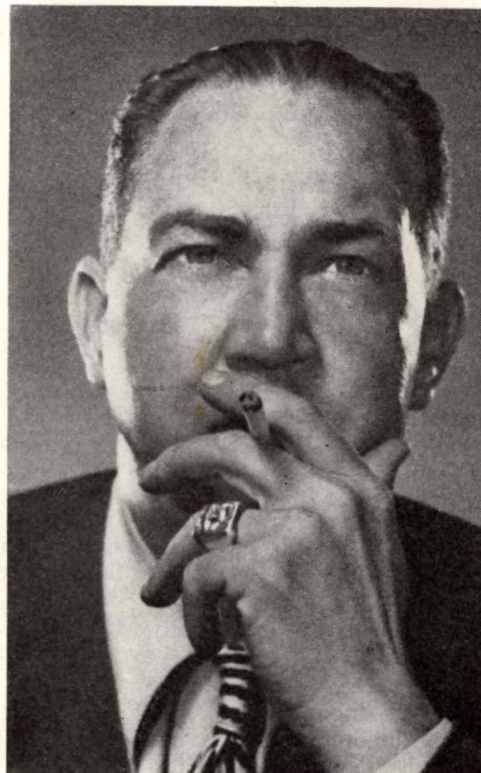


Evolution of the Hamilton Standard blade within the past decade. Tips especially have become broad and thin; blades are stronger and heavier

An OPEN DOOR for the AIRCRAFT INDUSTRY

CHARLES H. BABB

President of The Babb Company, Inc.



Charles H. Babb

THE U.S. aircraft industry has an opportunity to serve the aviation markets of the world in a big way. But the industry will lose that opportunity if each manufacturer does not establish a better system to take care of overseas customers. Although we have the products, backed by tremendous production and research facilities, and although we now enjoy customer preference for our products, overseas buyers will not beat a path to our door.

Unless foreign airlines are sure they can get replacement parts, maintenance help and technical assistance which make it possible to use American equipment at top efficiency, they will not buy American when it comes time to modernize their present fleet. And this time will come soon. Foreign airlines are building up reserve funds with which to procure new equipment and the Marshall Plan is relieving the current dollar shortage.

Today, overseas airlines are using 15 times as many U.S. planes as they did in 1939. Moreover, during the war, the U.S. equipped more than 1000 air bases beyond our shores at a cost of almost three billion dollars. These bases are being used as part of a commercial airline network by 68 countries. We have a chance now to demonstrate that we are able to furnish adequate U.S. made supplies.

This problem is not nearly as important in dealing with the large airlines who fly the transatlantic routes, have well staffed purchasing offices based in the U.S. and sufficient operating capital to keep large warehouses stocked with spares for their anticipated needs. But it is of crucial importance to understand this problem if we are to do business with the smaller airlines which operate domestic routes in Europe, South America, Africa and the Far East.

To get a clear picture, let's imagine that U.S. airlines were equipped with French planes. Suppose we had to get all our aircraft, spares, shop equipment and test equipment from France. Suppose we were forced to deal with French salesmen who had no knowledge of U.S. operating conditions, of export and import regulations, of how to convert

dollars into francs—who could not even speak English.

Suppose our maintenance personnel was unfamiliar with French equipment, that standard threads and dimensions were in millimeters instead of inches. Suppose catalogs, instruction manuals and maintenance charts were in French, a language our mechanics could not understand. Does this spell confusion? Certainly. Yet this is the problem faced by European airline operators today.



If U.S. plane manufacturers are to protect their stake in world aviation they must act now. They must make sure that they have in each country representatives who speak the native tongue, who are highly skilled technically, and, perhaps most important, who possess a knowledge of the economics and the philosophy of the country in which they operate. They must understand business modes and practices and be capable of conducting educational programs to update European technicians who had no chance to keep up with the tremendous advances made by the U.S. during the war.

These representatives must be sympathetic and anxious to help each European airline solve its problems by calling on the common fund of information available in the U.S. pertaining to air safety, maintenance, operation and other matters. They must not be too eager for quick results; short-range plans must be oriented by a long-range point of view. For instance, sales of capital equipment to an airline must not be so large that the customer is left with insufficient funds to maintain that equipment at its maximum efficiency.

The representative must be thoroughly conversant with all details of currency regulations, import regulations and other necessary paper work without which no effective plan can be carried into operation. The attitude of the U.S. manufacturer toward the market must be one of expecting a reasonable profit spread over a number of years. There

is no market in Europe today to be exploited. There definitely is one to be cultivated. Fear of war must not make us lose sight of this market.

Neither must we lose sight of the fact that U.S. plane manufacturers need this market. Since the war, even though most of Europe's airlines were able to get surplus U.S. equipment through the Office of Foreign Liquidation at bargain-counter prices, still, in 1947 our manufacturers sold \$175,000,000 worth of new planes overseas. In fact, one-fourth of all our civil aircraft production found its way into this market. More than one-fifth of the Douglas DC-6's and Consolidated Vultee *Convair-Liners*—one-fifth of Boeing's *Stratocruisers* on order—and one-half of the Lockheed *Constellations* that were sold went abroad.

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The President's Air Policy Commission Report last year underscored the larger implication of these markets: "The export of aircraft and aeronautical materials provides a volume of business which, by helping to sustain the industry, contributes to the national-defense potential and to our economic welfare." By purchasing U.S.-made aeronautical products our overseas customers unknowingly help reduce U.S. taxes.

But to keep these foreign markets we must make good. Manufacturers in all lines have long known that a sale is a liability until the customer is made happy with his purchase. They also have known that the only way to assure customer satisfaction, whether with a washing machine or an expensive watch, is to provide ample servicing facilities to help with any problem that may develop.

By the very nature of the disposal pattern under the OFL, manufacturers were not interested in standing by to convince a foreign airline it should be happy. Had the OFL sold the equipment (as had been suggested many times) to the original manufacturer and then let him sell it to the airline, the situation would have been different. Instead, Government policy let the OFL cut our manufacturers off from their markets by dealing directly with the potential customer.

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U.S. surplus equipment was placed on the airlines of the world under these unfortunate circumstances. No sales job went with the equipment. No eager manufacturer stood by to insure customer satisfaction. The few representatives who were around were busy trying to convince airline operators that they should scrap their newly acquired surplus planes and buy the "latest model."

This situation was further aggravated by a wave of carpetbaggers who swept Europe simultaneously with the operation of the OFL disposal program. They were men of no resources and no knowledge of the nature of the complicated commodity they were selling. They had no scruples and were determined to exact fantastic profits out of a confused situation. They sold items of dissimilar equipment totally unsuited for the job it was to do.

For example, they would sell a cargo plane to an operator who needed a passenger plane, glossing over the sale by saying, "For a few dollars you can buy yourself some seats." Some operators were forced to spend many times the original cost of the equipment to convert before they were able to place their aircraft in service. A great deal of the good will U.S. manufacturers had built up through the years before the war was lost during the brief period that Europe was overrun by these individuals who operated on a day-to-day basis from a suitcase. Luckily this plague has since subsided.

About the Author

A PIONEER distributor of reconditioned and new aircraft, Charles H. Babb speaks authoritatively on worldwide sales opportunities.

His firm, of which he is founder and owner, acts as distributor, in the United States and in foreign countries for manufacturers of a wide range of aeronautical products. It was a supplier to both Army and Navy during the war.

Born at Eugene, Ore., in 1899, Babb learned to fly in California in 1919 and has been continuously active in aviation ever since. He has been credited with many innovations in adapting aircraft to difficult cargo-handling problems and has served as technical aviation consultant to the United States and to foreign governments.

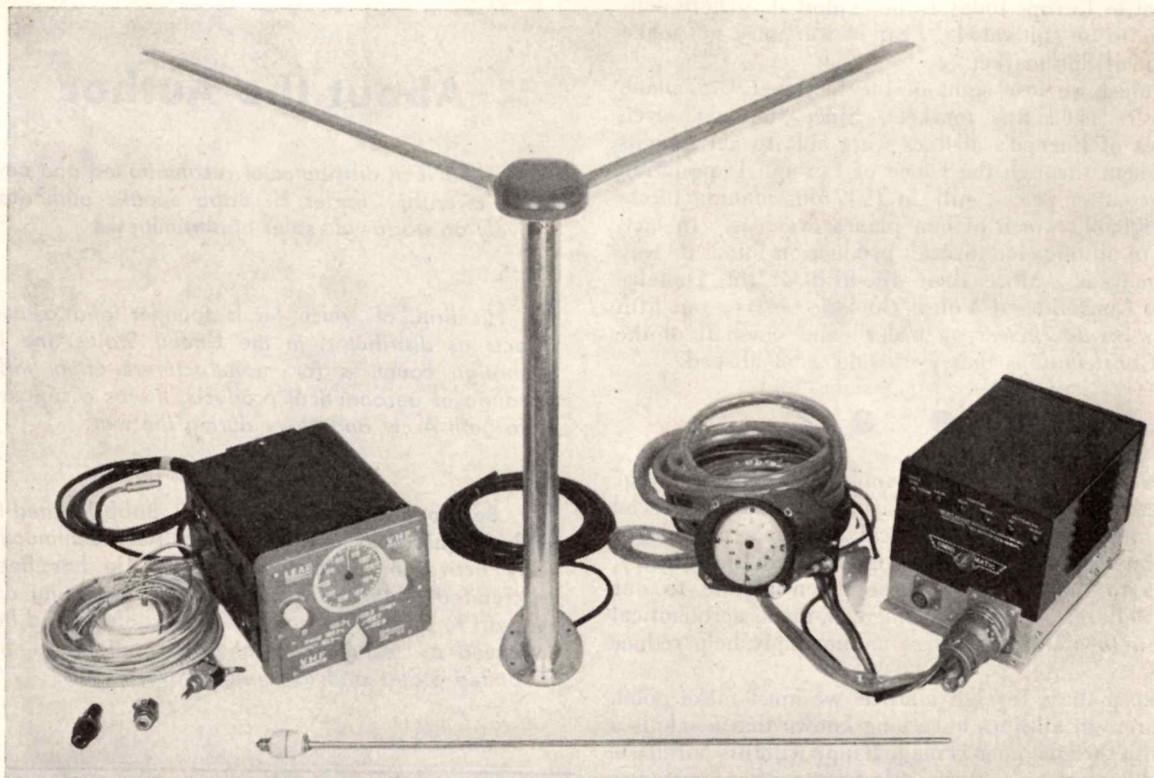
But it has left its mark. U. S. manufacturers today are asked to demonstrate that their selling plans have "inherent stability."

Far from being able to demonstrate this, most manufacturers have no permanent representatives abroad. Yet they are competing with manufacturers of other countries who have established headquarters. Moreover, these competitors get help from their governments. For instance, the British Government ("export or expire") goes all out in supporting its plane manufacturers to put British products on the airlines of the world. Seventy-five per cent of their production during 1947 went to export. Other governments, too, give financial assistance to airlines which will buy products of their manufacturers, and many governments constantly strive through trade exhibits and other means to familiarize workmen with their national products.

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Our government also can do much to help manufacturers. It was suggested in the President's *Air Policy Commission Report* that the "Export-Import Bank should, we believe, be utilized as a financing medium to aid in making sales of aircraft and aeronautical equipment in foreign countries. The Export-Import Bank now requires that the manufacturer shall assume up to 25% of the credit risk. This is beyond the financial means of most of the American aircraft manufacturers at the present time. In view of the national-defense advantage, we believe the Bank should be authorized to assume a large share of the credit risk on export sales of aircraft and aircraft equipment."

Our U. S. manufacturing industries that produce aviation supplies need not stand around and wait for Government help. Even without it, we have the product, facilities for production and research, and we can command the market. But we must be prepared to be there "firstest with the mostest" when it comes to providing parts, service and maintenance help wherever U. S. products are sold.



"Omnimatic" components. Receiver-transmitter at left, remote controls are available; "V" dipole antenna in center; scope amplifier and power pack at right. Scope (right center) fits standard panel opening

Lear Introduces "Omnimatic"

AIR NAVIGATION still is one of the piloting skills which remain to be simplified sufficiently to make the personal pilot confident of reaching his destination even though he be in strange territory or confronted with marginal visibility conditions.

The CAA is backing up its confidence in the Very High Frequency Omnitrange system as a primary aid to aviation by installing some 470 ground stations, of which more than 300 are already in operation. These will eventually replace the kilocycle-frequency radio ranges with megacycle frequencies. The CAA is also promoting the VHF Instrument Landing System for improved airline schedules with safety during periods of low visibility.

The airlines are busy installing related equipment in those aircraft not yet supplied and it will not be long until VHF will rule the aircraft radio roost. All this has left the lightplane owner pretty much out in the cold. Weight, bulk and cost of VHF airborne equipment have all been barriers to the private pilot—perhaps the very person who needed VHF the most, since he can not keep himself on the

keen edge of instrument-flight proficiency, which is the airline pilot's normal life.

The CAA has encouraged designs of lightweight VHF equipment, at a reasonable price, and several have been announced.

The most recent is by William P. Lear. His VHF receiver and transmitter installed in the average aircraft will cost approximately \$400. In addition, Lear, Inc., offers related accessories which make the installation an *automatic* radio-navigation system. All the operator has to do is tune in the desired station and a scope indicator gives the exact compass course to the Omnitrange station selected, regardless of the heading of the airplane at the time.

How It Works

Lear *Omnimatic* (VOR) provides instantaneous automatic bearing indications and continuous tuning throughout the 108-127 mc band, bringing in VHF radio ranges (VAR), airways and airport-voice communications.

The indicator is the face or screen of a 3-in cathode-ray oscilloscope tube, calibrated in degrees of azimuth. The

particular Omnitrange station tuned in appears on the screen as a pip on some point of the compass circumference. This point is the magnetic bearing of the station tuned in.

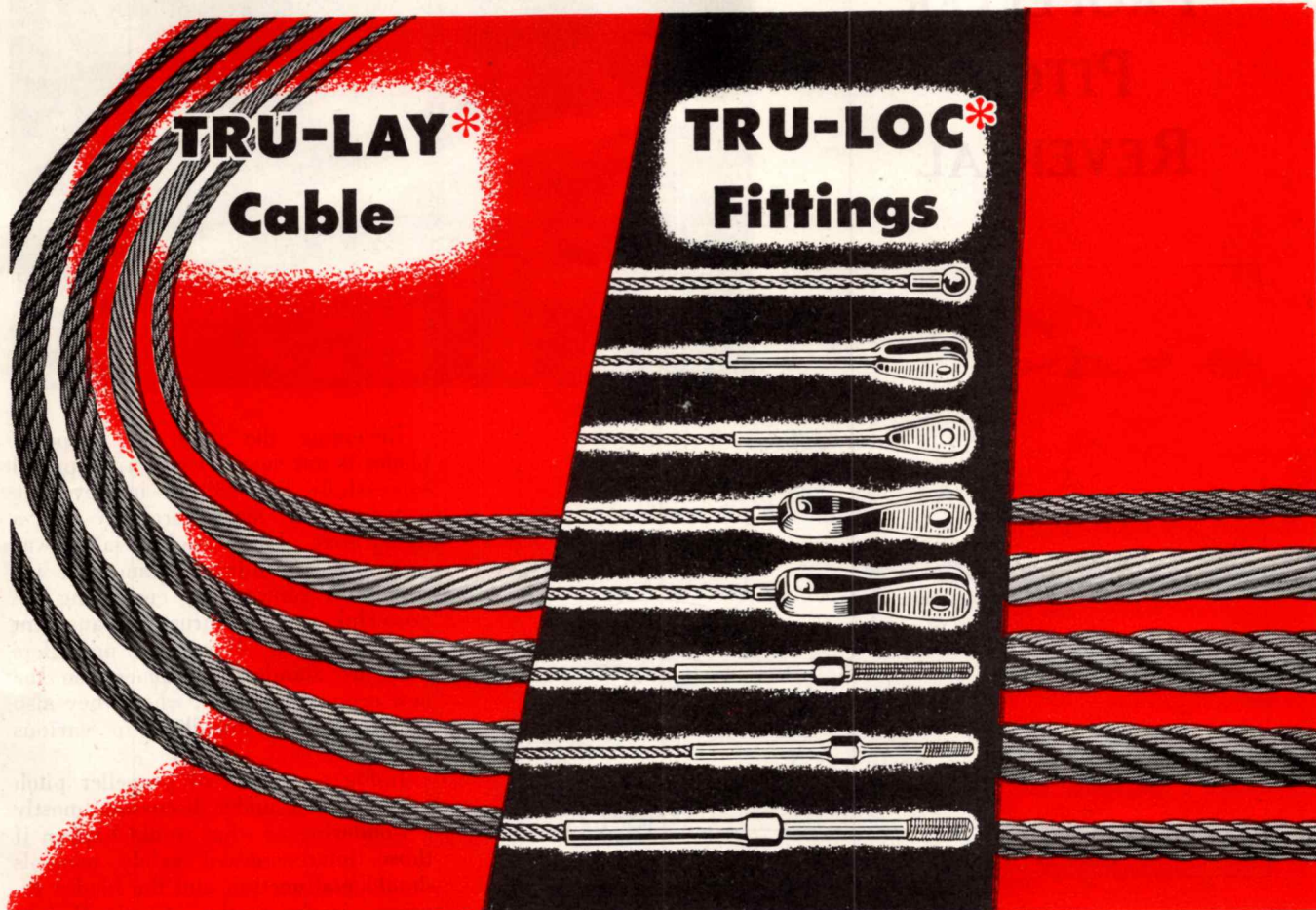
It indicates to the pilot where he is in relation to the station being received. An accurate position fix may be obtained by tuning in two Omnitrange stations, noting the bearing indications on the scope and plotting the intersection on a map. Also included is an adapter which permits visual reception of all the VHF visual-aural ranges.

Four different services are available with Lear *Omnimatic*: Communication with control towers and radio-range stations; Omnitrange bearing indications; visual-aural course indication; and instrument landings using the runway localizer.

Simplicity marks the operation of the set. It is necessary only to tune to the frequency of the facility desired. When a VAR range signal is tuned in, the course indicator will show whether the plane is in the blue or yellow quadrant and, by listening to the signal, the pilot can tell whether it is the A or N quadrant.

(Continued on page 101)

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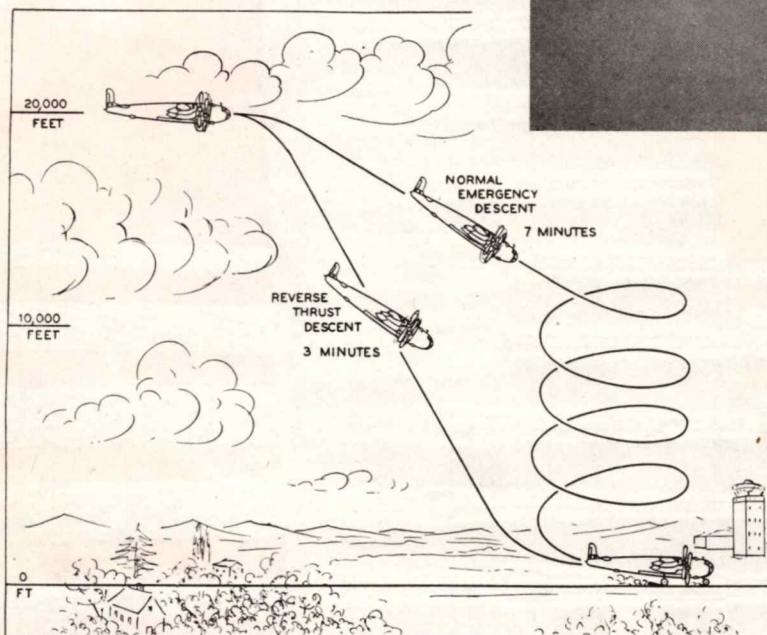
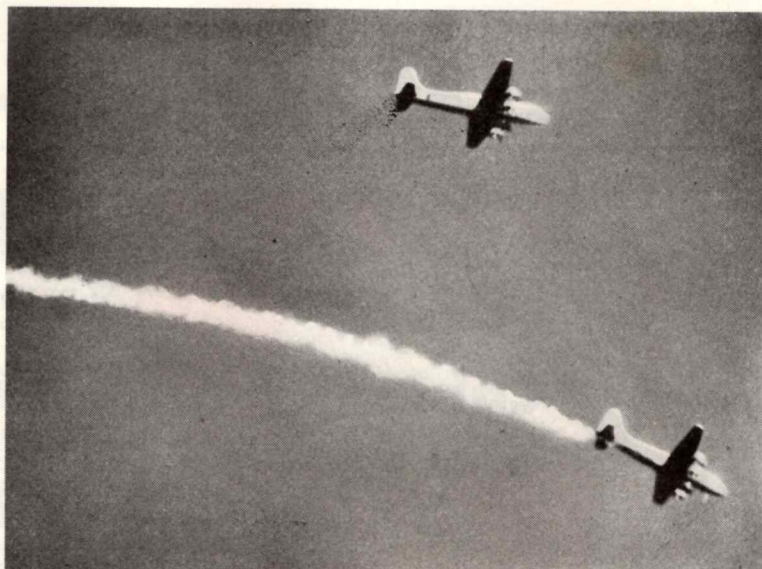


Photo shows steep angle of descent of test plane (identified by white smoke) compared with more moderate angle of accompanying transport under emergency letdowns. Sketch portrays flight procedures and elapsed time from 20,000 ft.



Reversing the pitch of propeller blades is not new. It was first applied successfully in 1939 to improve the water-surface maneuverability of a flying boat. Later, landing safety was increased on military planes on icy and short runways by employing the powerful reverse thrust to augment wheel brakes. Reversing propellers now are standard equipment on the new crop of airliners, where they also aid in ground handling in various situations.

In-flight reversal of propeller pitch has long been under discussion, mostly a wondering of what would happen if those interconnected safety controls should malfunction and the blades reverse inadvertently. Curtiss-Wright deliberately went after the answer with a standard Air Force C-54 transport, equipped with production Curtiss Electric reversing propellers. A special by-pass switch made it possible to reverse the blades even though the weight of the aircraft was not on the landing gear, which is the normal safeguard against reversal in the air.

The tests were begun by reversing the pitch on pairs of engines in various combinations, and by using one specially instrumented engine to locate performance limits. Then the four engines were reduced to idling speed, the reversing switch was actuated, and, as soon as the blades had come to zero pitch and started in reverse, the engine rpm was increased to avoid reverse windmilling of the powerplants.

Test Pilot Fisher reports no unreasonable handling characteristics. There seems to be some vibration in the tail group and the stalling speed is increased approximately 25 mph, as was expected. The aircraft should be equipped with a constant-speed control for the reversed-pitch operation. Also,

(Continued on page 91)

CONTROL of aircraft under normal flight conditions has become a somewhat routine procedure—in fact it was turned over to mechanical robots long ago.

Emergency conditions in the air are another matter. A new chain of procedures is brought into play, and the pilot had better know his lesson well. Each incident is at least just a bit different from any other and the pilot has to think his way through the difficulty. A wrong move can bring into play contributing factors which may bring on further calamity.

No matter what the emergency, a quick letdown is generally indicated, if not urgent. This is particularly true in the case of fire, explosive decompression of a pressurized passenger cabin at high altitude or where military transports or multi-engined bombers benefit by a rapid descent to evade flak or attacking aircraft.

A rapid rate of descent is accom-

panied by a high forward speed. This may not be a particular disadvantage to a fighter aircraft. However, the multi-engined, propeller-driven airplane has a placarded dive speed which may not be exceeded safely. Thus, the emergency descent must be made under a more moderate glide angle not to exceed the specified speed, all of which consumes precious time in the case of a serious emergency.

The Curtiss-Wright Solution

The Propeller Division of Curtiss-Wright Corp. may have the answer. In a carefully planned flight program—plotted and executed by Chief Engineer George W. Brady and Chief Test Pilot Herbert O. Fisher—it has been demonstrated that a four-engined transport can be brought down at a rate exceeding 10,000 fpm, at a forward speed below 200 mph. This is achieved by reversing the pitch of all four propellers in flight.



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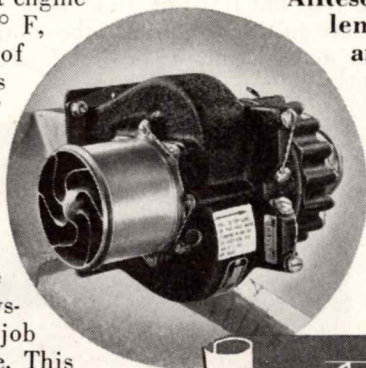
Pioneering the design and manufacture of refrigeration turbines, heat exchangers, superchargers, cabin pressure controls, and complete pressurizing and air conditioning systems for aircraft has been the basic job of AiResearch for nearly a decade. This has called for new techniques in building and controlling high-speed wheels and rotors—often operating in excess of 100,000 r.p.m.

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and military high-altitude and jet-propelled airplanes under construction or flying in the U.S.

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AIRSHIPS in the U. S. NAVY

"Corn and beans are important foods but we don't grow them in the same field or package them together. Admitted or not, 'Naval Aviation' still unrealistically mixes airplanes and airships. It is my opinion that naval air aspects of the national defense will thrive best on straight dishes rather than on aeronautical succotash"



VICE ADMIRAL C. E. ROSENDAHL, USN (Ret.)*

C. E. Rosendahl

IN A strikingly informative Navy Day 1948 press release, the Department of the Navy has just given the public a timely report on the completion of a year of unparalleled progress in "Naval Aviation." The topics covered therein are comprehensive: operational achievements; Naval Reserve Aviation Cadet programs; better fuels; research in guided missiles; better reciprocating and jet engines; jet-powered attack bombers and carrier fighters; new seaplane types; new transport planes; non-inflammable hydraulic fluid and super-octane aviation gasoline; all topped off by a "new sea giant," the 65,000-ton super-carrier. This report indicates that "Naval Aviation" seems to know where it is headed and is well on its way, certainly in the field of winged aircraft.

On occasions there have been indications that "Naval Aviation" included also at least a few lighter-than-air craft or airships. Thus, only a few weeks ago, in September, the Navy issued a brief factual press release announcing award of a contract for the design of a new-type nonrigid airship. Now, however, with perhaps greater significance than may be generally appreciated today, it could be interpreted from this excellent Navy Day report that "Naval Aviation" is composed exclusively of winged aircraft, for the report contains not even the remotest

reference to airships. Actually, of course, despite no mention of them, there are a few airships—and very active ones—in the naval establishment today.

Could it be that "Naval Aviation" has really forgotten the airship, or is it simply better ball not to call attention to the muddled, side-stepped airship situation? Or, on the other hand, could it be that omission of the airship from this latest report on "Naval Aviation" constitutes tacit agreement with my long-held conviction that airships do not belong under the "Naval Aviation" winged-aircraft arm but in the separate category of "displacement aircraft?" In any event, the Editor of AERO DIGEST has not forgotten airships and here is the brief report thereon he has asked me to prepare.

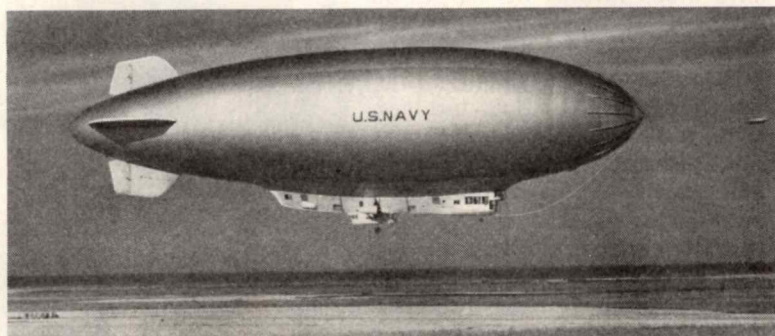
With justifiable pride, the Navy states that by July 1949 "total naval

air strength will reach its authorized strength . . ."—that is in *planes*, of course. But by neither word nor deed does there appear to be any naval intention of providing even partially corresponding strength in airships. Indeed the conclusion might readily be drawn that airship strength is being held down to the minimum that will permit acknowledgment of airship existence.

Time's Awasting

Yet this strange situation exists despite admission, high and low, of the terrible menace presented by the ever-improving submarine, and despite the fact that the airship is one of very few anti-submarine weapons remaining from World War II that possess potentialities for dealing with the new, highly developed submarine menace.

At practically every opportunity,



U. S. Navy Non-rigid Airship XM-1, which in 1946 set a new world's record for endurance in self-sufficient flight for any type aircraft. Flight of 170.3 hours well exceeded previous record, held by Russia

*The opinions or assertions contained herein are the private ones of the writer, and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

naval writers and speakers stress strong submarine and anti-submarine forces as major requirements of our modernized naval establishment. With increasing ingenuity, the submarine has already acquired a wide and growing list of capabilities in warfare. Very recently, *Jane's Fighting Ships*, authoritative publication on the world's navies, said that Russia has 250 submarines in service and "fully 100 more under construction," and that it is evident that Russia is inclined to rely chiefly on the submarine as a naval weapon. "Strategic bombing" is today a common topic of discussion.

Fangs for the Sea Wolves

As sure as fate, guided missiles and their launching equipment adapted to modern undersea craft will sooner or later make of the submarine a most effective "strategic bomber" possessing unequalled evasive ability to move skillfully into accurate range of enemy objectives and then retire with minimum chance of detection and destruction. Altogether, one would think that development of as promising an anti-submarine weapon as the airship would today be most vigorously prosecuted on a realistic basis. It should also be remembered that Russia has a supply of helium and has begun a program of airship development, reportedly for trans-polar operations.

But let's see just what is being done in the field of naval airships, there being no such craft in other branches of the Armed Services. Today, our naval airship forces in the field consist of two airship squadrons, each of four operating "nonrigid" airships—so long termed "blimps" for no sufficient reason except that they were "Type B-limp." Both airship squadrons are located on the Atlantic coast, one basing at NAS Lakehurst, New Jersey, and the other at the Naval Air Facility, Weeksville, North Carolina. Detachments from these squadrons operate in the Key West area and very occasionally at a few other East Coast points.



During World War II, K-type airships, like this one shown in flight over its Goodyear construction hangar in Akron, were used for anti-submarine patrol

On the Pacific Coast, there are no airship activities whatsoever, the one post-war airship squadron having been shifted to the East Coast on the very heels of a public statement by the Commander-in-Chief of the Pacific Fleet that there were then in the Pacific large numbers of foreign submarines, and despite the desired continuation of excellent services of other kinds to extensive naval training groups on the Pacific Coast.

These two remaining airship squadrons are operated by a pitifully small number of personnel. Yet despite various artificial hazards, these few airships and their limited personnel are enthusiastically and strenuously devoting themselves to the improvement of the craft and their tactics, with the result that the actual and potential value of airships is gradually becoming appreciated, particularly by our submarine people and by the few others

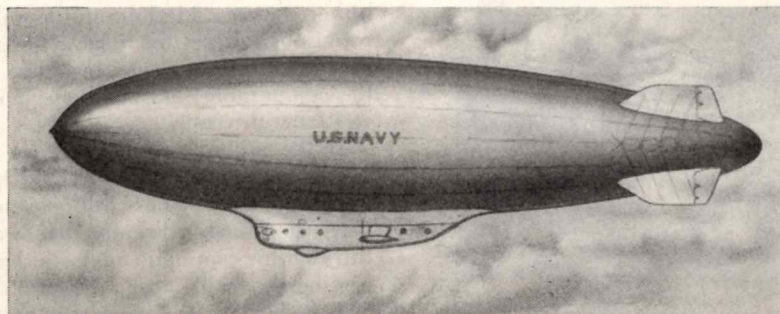
who are fortunate enough to witness our airship operations.

Airships, like any aircraft or surface vessels, require bases and facilities from which to operate. The Naval Air Station, Lakehurst continues to be the hub of our naval airship operations and development. There, major overhaul, training and experimentation for airships are carried on. Lakehurst serves as the main base for Airship Squadron ZP-2; Naval Reserve Airship Squadron ZP-51; Helicopter Squadron HU-1; and supports training schools for parachute men and aerographers. The former Naval Airship Stations at South Weymouth, Massachusetts and Glynco, Georgia operate on a minor basis and serve primarily as storage points for airplanes and occasional airship operations on an expeditionary scale. The former naval air station at Weeksville, North Carolina primarily provides for plane storage but also supports Airship Squadron ZP-1 as its main base.

Closed or Taken Over

Former naval airship stations at Houma, Louisiana; Hitchcock, Texas; and Tillamook, Oregon, are completely closed. The former naval airship station at Santa Ana, California has been taken over by the heavier-than-air branch which it serves in various capacities on a somewhat minor scale. The Naval Air Station, Moffett Field, California, though specifically authorized by Congress and built for airship purposes, also is in the hands of the

(Continued on page 102)



Official U. S. Navy photos

Artist's conception of new N-type, largest non-rigid, lighter-than-air craft ever planned. Nearly twice the size of World War II types. the "N" will be capable of long-range patrol over open ocean areas

Congress No. 81

Work in hand is to teach new legislators the aeronautical facts of life to insure their best support of supply bills coming in late spring

KENDALL K. HOYT
Washington Editor



FIRST job in Congress is to start educating the dozens of new members. Some of them know a good bit about aviation. All may be credited with wanting to build it. But the working details will be developed only by long hearings before the reorganized committees of Senate and House.

As the hold-over air-policy bills are reintroduced to start from scratch in the 81st Congress, official and industry witnesses will be in again to review the increasingly urgent reasons for action. The main need, as always, is to make a case for adequate appropriations in the supply bills which will be passed in the late spring.

For the Air Force, Senator Tydings and Representative Vinson, Armed

Services chairmen of the respective houses, have promised to expedite bills to authorize the 70-group program which was begun by a supply measure last year without specific enabling legislation. Vinson goes further in demanding 70 groups in-being rather than just on paper.

An authorization, of course, does not mean action unless backed up by actual funds. The half-billion-dollar National Airport Program is an example. Whatever the Armed Services Committees may do, the Appropriations Committees decide the cash amount.

The 70-group hearings, none the less, will develop much favorable publicity for air power at a time when it is most needed. Five-year-planning authority

can be a part of the same bill. Naval Aviation needs no legislative authority as to number of planes since existing law covers the 14,500-plane complement. But improvements in procurement laws, including a better deal as to renegotiation and profit limitations, will help both Air Force and Naval programs.

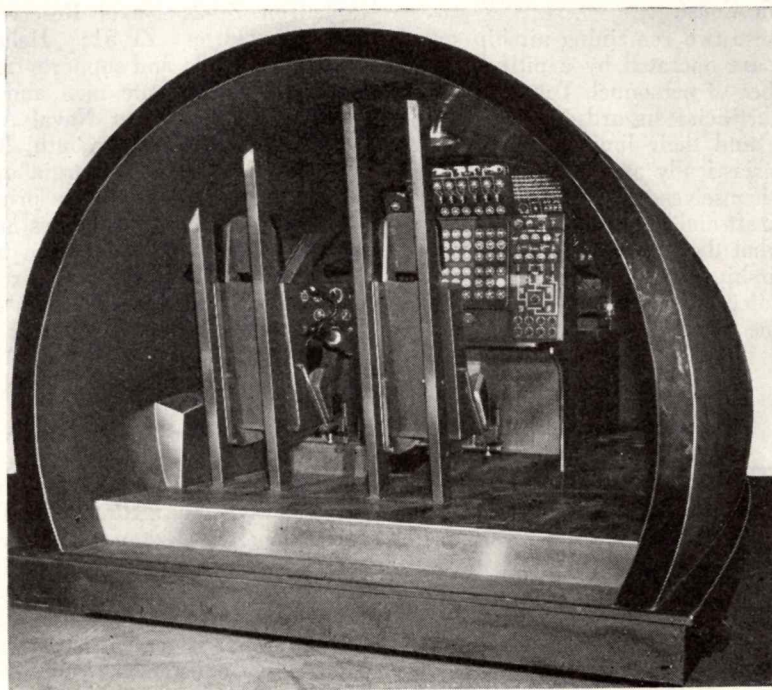
Bear in mind, however, that this is merely prelude to the battle of the budget. By the time this is printed, the big budget book will be made public for the fiscal year ending June 30, 1950. The Budget Bureau has been working on strict orders to hold all military spending within \$15 billion—approximately \$5.0 billion for Air Force, \$4.8 billion for Army, \$4.6 billion for Navy and \$0.6 billion for stockpiling.

This huge sum will mean continued expansion for the aircraft industry. But it falls some 19 groups short of supplying a 70-group Air Force. The Naval plan for 12 active carriers and 24 carrier groups would have to be reduced to about 8 carriers and 14 groups. The Army program likewise would be reduced; a cutback in draft quotas has been announced and universal military training is not within present reckoning.

Rising costs and wages, increased manpower in the Armed Services and depletion of war surpluses, which hitherto were a big item in the military programs, all act to make a budget in the \$15 billion range buy less than the comparable sum being spent in the 1949 fiscal year.

If the military leaders get as much as they want, \$23 billion would be the total figure. A \$17.5 billion sum has been discussed. Truman has warned through his economic advisers that any big increase will cause a Federal deficit and a shortage in manpower and materials so that, if Congress ups the spending total, higher taxes and stand-

(Continued on page 85)



Cockpit standardization mockup for very-heavy bomber types by Goodyear Aircraft Corp., under direction of Air Material Command. Pilot is located forward on centerline of fuselage; flight engineer is below and directly behind; co-pilots sits at his left. Mockup is to guide future construction.

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AMERICAN TIGER BRAND CONTROL CABLES

UNITED STATES STEEL

Ceramics for Molybdenum

THE lack of materials with the required properties for operating temperatures in excess of $1800^{\circ}F$ has been the main restrictive factor in the development of aircraft gas turbines, ramjets, pulsejets and rockets. At NACA's Lewis Flight Propulsion Laboratory, Cleveland, a good deal of work is being done with some new substances called "ceramels." These are materials formed by mixing ceramics and metals, and their ability to resist extraordinarily high temperatures makes them eminently suitable for use in the new-type hot-air powerplants.

As an important part of this program the National Bureau of Standards, under the sponsorship of NACA, has directed scientific investigations toward the development of ceramic coatings for the metals having very high melting points, in order to protect them against oxidation at high operating temperatures. Preliminary results indicate that molybdenum with an especially designed ceramic coating offers a promising combination for very high-temperature service.

Most of the usual heat-resistant alloys begin to melt when heated within the temperature range of $2400^{\circ}F$ to $2600^{\circ}F$. Certain metals have high melting points, but lack adequate resistance to oxidation. These include titanium ($3270^{\circ}F$), zirconium (3450°),

molybdenum (4750°), tantalum (5160°), and tungsten (6100°). The last three are of especial interest for applications in very high temperature service, but from a practical viewpoint only molybdenum is available in substantial quantities in the U. S. Hence its selection as one of the first of the new "super-duper" alloys.

The ceramic coatings are applied in the form of water suspensions or "slips" to cleaned specimens of molybdenum by either dipping or spraying. After drying, the pieces are fired at a temperature of $2150^{\circ}F$ in oxygen-free atmosphere. Some of the coatings which were developed were outstanding in resistance to thermal shock while others had good resistance to high temperatures.

One of the better coatings, M-13-33,

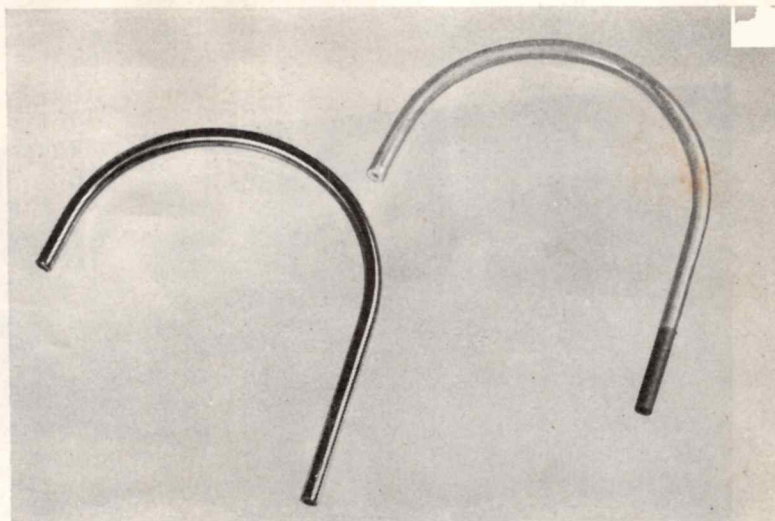
consisted of (1) a base coat of a low-expansion frit with 20% zirconia added, (2) a cover coat containing 95% zirconia and (3) a seal coat consisting of a thin application of the same composition as the base coat.

The Bureau of Standards subjected coated specimens to several significant performance tests. These included heating in a gas oxygen flame, heating at constant temperature in an air atmosphere, and service testing in the blast of ramjet engines.

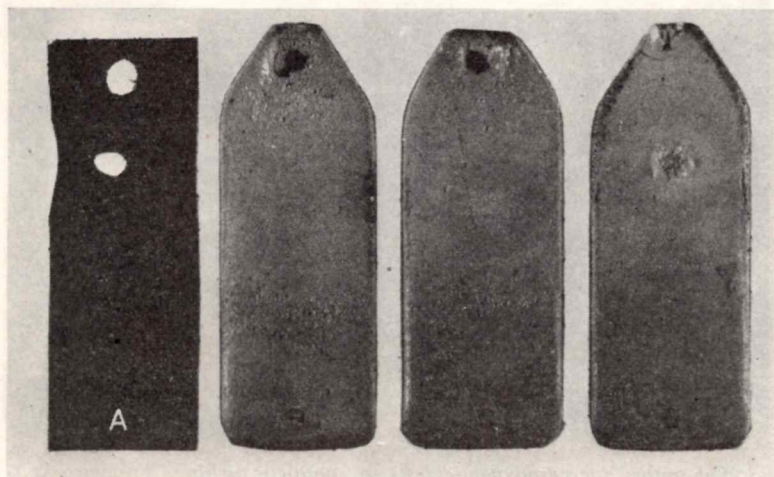
The results of these various tests indicated that the oxidation of the molybdenum was greatly retarded by the best of the ceramic coatings tried. In an air atmosphere at $1650^{\circ}F$, unprotected molybdenum sheet was found to decrease 0.02 in in thickness in one-half hour. There was no decrease, however, for ceramic-coated molybdenum heated for 70 hours under the same conditions.

The four specimens (illustrated at left) demonstrate the protection afforded molybdenum by the presence of a ceramic coating. They were photographed after high-temperature flame tests at the National Bureau of Standards. Specimens B, C and D, which are protected with a high zirconium-oxide coating approximately 0.033 in thick, were treated for 30 minutes at surface temperatures of 2600° , 3000° and $3400^{\circ}F$ respectively. Specimen A, which is uncoated and 0.040 in thick, developed a hole in three minutes under the same flame adjustment as that applied to D, while all coated specimens showed no decrease in metal thickness after the respective treatments.

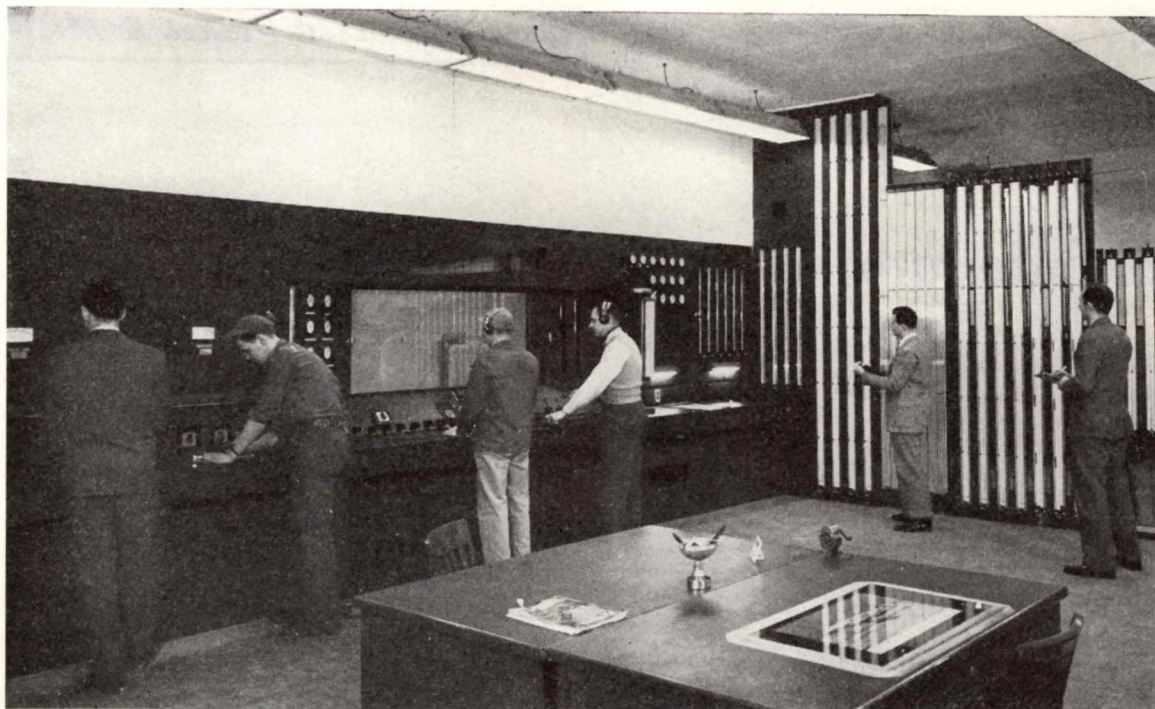
(Continued on page 87)



Ceramic-coated molybdenum pitot tubes (at right), used to record pressures in the $3000^{\circ}F$ blast of a ramjet engine, gave satisfactory service in the simulated service tests at National Bureau of Standard labs



These specimens photographed after high-temperature flame tests at NBS indicate the value of ceramic coating on molybdenum (see text)



A crew records data in the control room of an engine test stand at Packard, Toledo

Packard's Jet-Engine Test Facilities

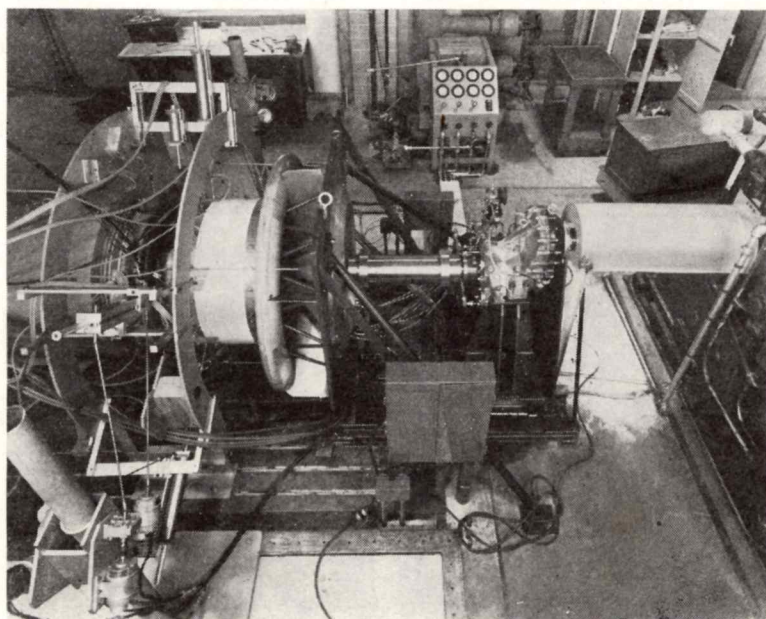
THE Aircraft Engine Division of the Packard Motor Car Co. is now operating just outside Toledo \$10,000,000 facilities for the exclusive development of gas-turbine and related types of engines. Work on the new-type powerplants for aircraft and guided missiles has been under way since V-E Day, under an agreement with the Air Materiel Command. All information on the new engines is classified.

The test facilities, with complex laboratories for every phase of gas turbine research, are now just about complete. Some of this country's leading engineers head up the experimental and developmental work at the Toledo works. They include Arthur Nutt, director of Packard aircraft engineering and manager of the facilities, former SAE president; C. E. Mines, coordinating engineer and assistant to the manager; Robert M. Williams, chief engineer; and C. P. Weedman, administrative engineer. There are more than 550 persons assigned to the new program, with an average age of about 35. They have come from all parts of the country, attracted by the challenge of a new field.

Packard president and general manager George T. Christopher and director Arthur Nutt have recently revealed some details about the Toledo facilities, which consist of nine modern

buildings containing 367,910 sq ft of floor space. They include complete laboratories for intricate research on every component of a gas-turbine engine. As director Nutt explains: "The main units of a turbojet engine are

the compressor, combustor and turbine. The net output equals the difference between turbine and compressor power. Effects of each unit on the others preclude accurate analysis of a complete powerplant. Therefore, each unit



Laboratory for aerodynamic tests of complete turbine. Framework at left carries remotely controlled motors for instruments inside turbine housing; shaft and gear-set in center transmits turbine's power to dynamometer at right; cold air aids performance predictions

—and the various parts of each unit—must be tested and developed individually.”

Among the various laboratories are those having to do with electronics, instrumentation, mechanical accessories, burner research, fuel flow, stress, turbine wheel and blade test, air flow, metallurgy, heat treat, combustion and many other fields. There are numerous test cells; several shops, such as those for sheet metal, machining, and tool and die work; and a large spin-test pit with a drive turbine that will support assemblies weighing up to 1,000 lb and driven at speeds up to 25,000 rpm.

Large Capacity

The dynamometers can absorb up to 8000 hp. Air-handling and refrigeration equipment can simulate altitudes up to 50,000 ft in tests on jet engines developing powers required in modern fighter planes. As many as 270 separate test measurements can be made on an engine at the same time. The potentialities of Packard's facilities seem almost unlimited in their application to the expanding field of aircraft gas-turbine development, according to the engineers heading up the work in Toledo.

Three of the wind tunnels used for experimentation are of unusual interest. Two of these are supersonic and one is of vortex or whirlpool design. Artificial wind is forced through these tunnels, and objects are placed therein for investigation of the air flow around them and the aerodynamic forces exerted upon them.

The larger of the supersonic tunnels is 70 ft long, with a maximum circular diameter of 54 inches. First of its kind ever built, it is powered by electric motors capable of developing 4,200

hp. This special tunnel was designed to test some of the large single components of jet engines, or assemblies of two or three related items, depending on the size and nature of the items and the type of test involved. When a compressor blows the air through the tunnel, 22/3 tons of air can be handled per minute.

An interesting feature of the tunnel is that photographs can be made of air trails around the test object, using a

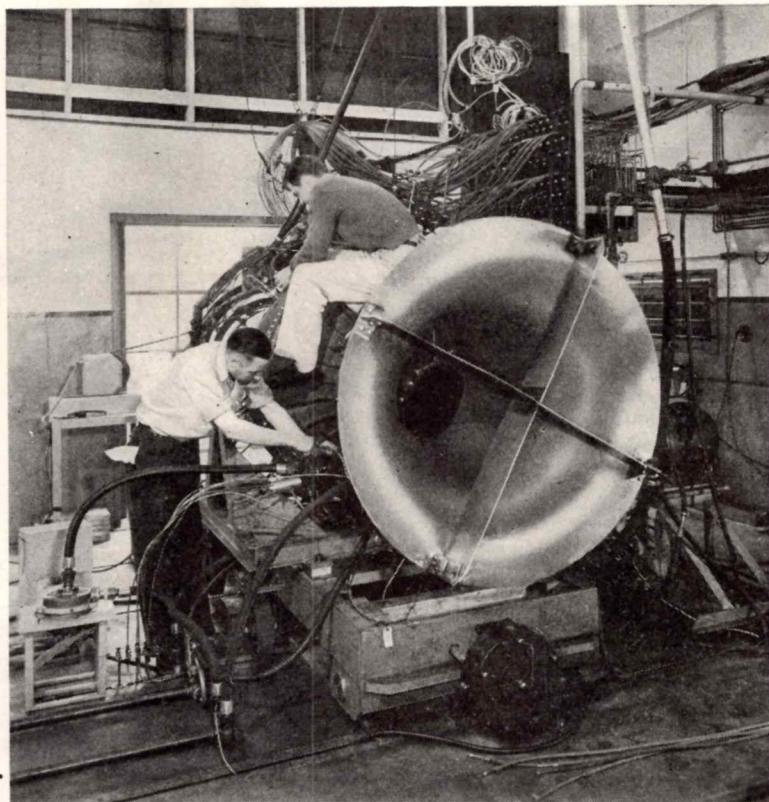
special light source and a camera designed for the purpose.

The “vortex” tunnel is another intriguing device, the effect of which can be likened to that of directing wind on a pinwheel. The blades of a pinwheel rotate fast or slow when air blows upon them, depending on the position of the blades with relation to the air stream. The correct position of the stator blades, in directing the hot gas to the turbine wheel to obtain the best result, is determined in the vortex, or whirlpool, tunnel.

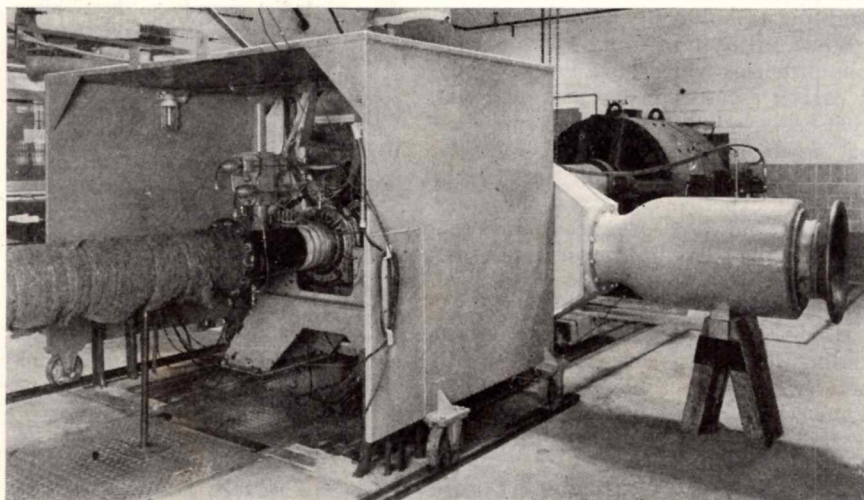
Each blade in a turbine wheel has to deliver upwards of 180 hp—or more than the most powerful automobile engine. There are scores of these blades in a turbine wheel, and each is shorter than a man's hand. The attachment of each blade to the turbine wheel is capable of supporting the equivalent weight of three Packard automobiles.

The combustor, or combustion chamber, in a gas-turbine engine is not as big as that of a household oil-burning furnace, yet the powerplant burns more fuel in an hour than 110 furnaces operating continuously for the same period. However, the oil-burning furnace is only about 70% efficient, whereas Packard engineers have already achieved an efficiency of between 95% and 98% with their experimental jet engines.

(Continued on page 86)



The maze of instrument connections on this thrust-measuring test stand provides the many thermodynamic measurements for modern gas-turbine aircraft engines, one of which is being here installed



Scale-model compressors are driven at speeds up to 30,000 rpm at Packard's Toledo jet-engine test laboratory. The dynamometer in background provides the 800 hp needed at these speeds for compressors only 12 inches in diameter

A McDonnell "Phantom," first of Navy's jet fighters, comes in for landing on a carrier, with full flaps. The "Phantom" is now operational in the hands of several East Coast fighter units, and also one Marine unit at MCAS, Cherry Point, N. C.



THE availability of practical gas-turbine type engines has enabled the airplane designer so greatly to increase the performance of fighter aircraft that World War II type propeller-driven fighters must, for most missions, be considered obsolete. All major air powers are concentrating on the rapid development and introduction into service of jet-powered fighter aircraft. Since it is likely that the Navy's carrier aircraft will, in the event of any future war, be heavily opposed by land-based aircraft, it is essential that your Navy's carrier fighter squadrons be equipped with the finest jet fighters which can be developed.

The Navy is well along in its transition from propeller-driven airplanes to jet propulsion for its first-line fighters. In service with Fleet units now are the McDonnell FH-1 *Phantom* and the North American FJ-1 *Fury*. Flying, but not yet in service use, are the McDonnell F2H *Banshee*, Grumman F9F *Panther*, Douglas XF3D *Skyknight* and the Vought F6U *Pirate*.

During World War II, when it developed that turbojets had become feasible powerplants for military aircraft, the Bureau of Aeronautics embarked on its jet-fighter program. That program progressed to the extent that now all new fighters are designed around the most advanced gas-turbine type powerplants.

The shift to jet propulsion gave rise to a series of questions and possible problems which were initially a cause of serious concern. It now appears that the majority of the design problems have been solved and that a good

start has been made by the squadrons and carriers toward solution of the operating techniques required.

When we bear in mind the tremendous problems which have been solved by carrier aviation in the past, and its great background of experience, we see that much of the groundwork for jet operation is already with us. Jet-operating experience aboard our carriers has indicated we need only to work out the specialized operating procedures which the carrier-based jet fighter requires.

However, before the first carrier landing of a jet was ever accomplished, there were some important requirements which would find answers only in actual operation. Some questions at the time were:

(1) Would the slow acceleration of jets give them the speed to get off a carrier deck without the necessity of being catapulted?

- (2) Would the absence of the propeller and its drag cause the extremely clean jet aircraft to "float" after the cut signal? Could the jet, then, make a normal, carrier landing?
- (3) Would jet exhaust present a real hazard to flight-deck personnel?
- (4) Would the desirability of starting engines immediately before launching lead to late discovery of "duds" with a consequent complication and slowdown of launching operations?
- (5) Would the higher fuel consumption at low altitudes making a prompt landing necessary, be too hazardous for a flight of jets to operate simultaneously from a carrier?
- (6) Would the suction of the jet intake present too great a hazard to close-working deck personnel?

Many other problems, naturally, came to mind immediately: added fuel

Fighters for the Flattops

CAPT. J. N. MURPHY, USN

Director of the Piloted Aircraft Division, BuAer

requirements, problems of taxiing and spotting planes on deck, the large power source needed for starting engines, and, by no means least, could a jet engage a barrier wire without decapitating the pilot?

The Navy does not yet consider that it has all the answers to operating jet fighters from carriers, but it is now evident that most of the initial worries noted above were not to materialize when it came to actual operational test. There are now no known problems to preclude successful jet operation from aircraft carriers.

The McDonnell Aircraft Company pioneered for the Navy in the pure jet field with the FH-1 *Phantom*. This is a twin-engine mid-wing fighter in the 500-mph class, powered by two Westinghouse J30(19XB-2B) turbojet engines. This model was the Navy's first jet to go aboard ship, making its initial landings in August 1946 aboard the *USS F. D. Roosevelt*. The *Phantom* is an operational fighter in Fighting Squadron 171 and Marine Fighting Squadron 122.

In May 1948, VF-171 conducted three days of routine carrier operations aboard *USS Saipan*, the Navy's smallest operational fast carrier using 16 *Phantoms*. As was noted in the press



Joseph N. Murphy

at the time, the operations were completely successful and no significant problems were encountered.

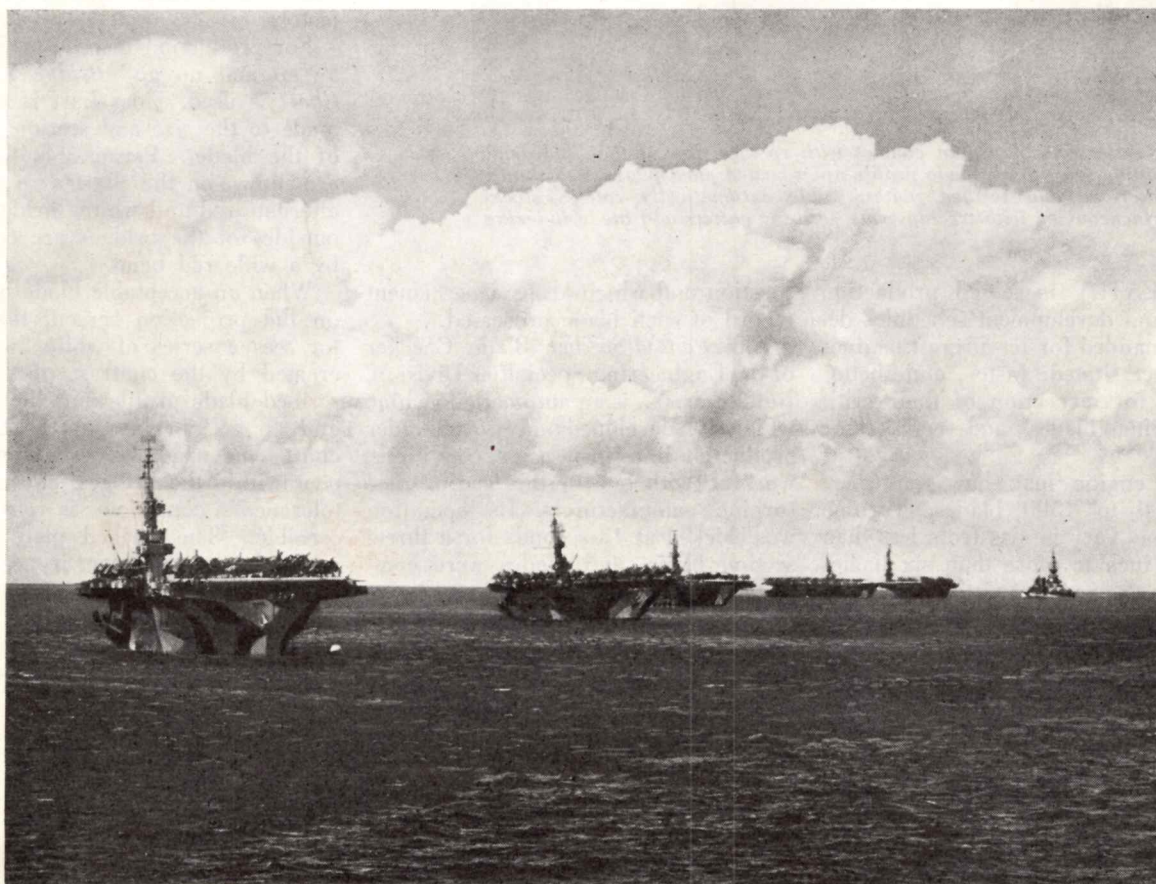
The 660-ft deck of the *Saipan* proved

to be adequate for takeoff, even though the plane used most of the deck to get off. Landings were made easily and no difficulty was experienced by the pilots. Furthermore, relatively slow acceleration out of arresting gear was offset by better taxiing and braking control of the tricycle gear. Deck personnel had no difficulty in spotting the airplanes. We found that possible deck-handling difficulties had been greatly exaggerated.

This series of tests with an operating squadron was one which we had been anxious to complete. It went smoothly, very nearly routine—which was also the way we wanted it.

The Eyes Have It

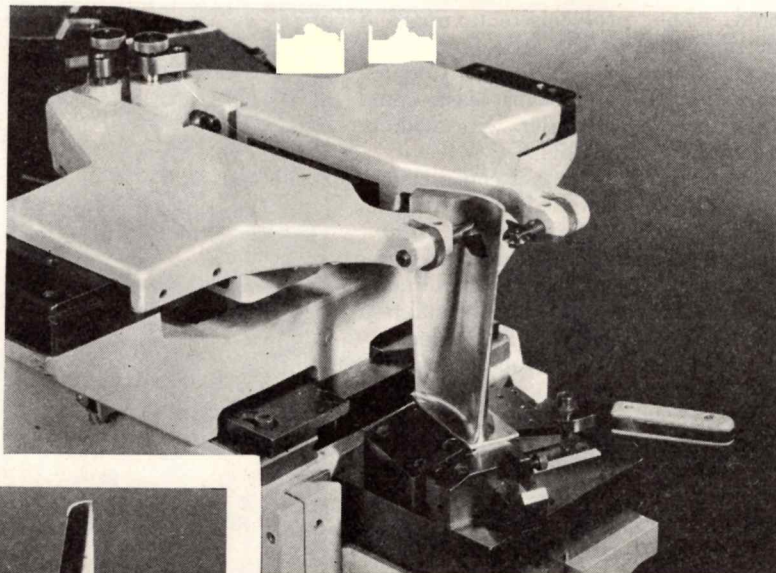
One of the real advantages in operating jets from a carrier is the excellent visibility which the pilot gets from his "office" near the nose. With most carrier planes, the pilot has had to contend with a large radial engine cowling blocking part of the view and making the last part of his approach and landing almost blind ahead. Then, if given a waveoff, the pilot immediately had to contend with the torque effect resulting from full throttle while turning and climbing away from the carrier. (Continued on page 96)



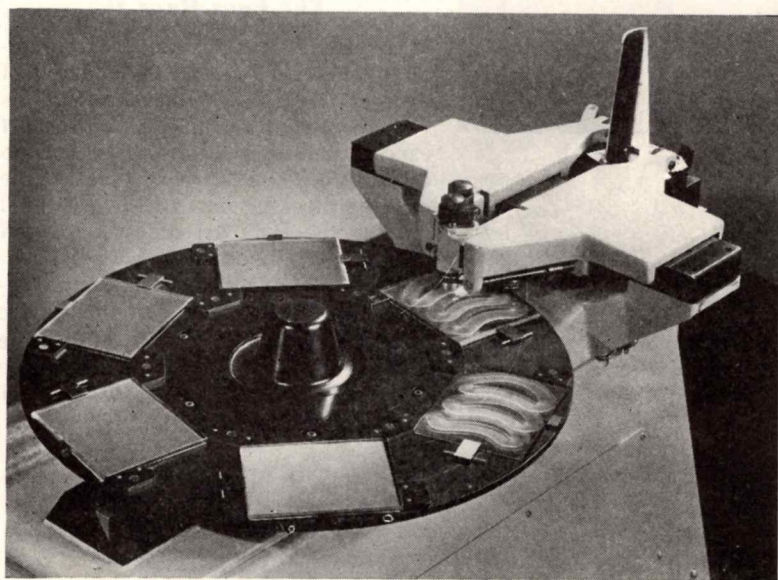
Official U. S. Navy photo

Five U. S. Navy baby flattops lie at anchor at an advanced base in the Far Pacific, with a heavy cruiser at right. Flight decks of these escort carriers (CVE's) are crowded with attack and fighter planes. After replenishing stores and other refitting, they resume their duties with the Fleet

CHECKING JET BLADES



Closeup of tracing rollers which traverse the blade profile across three or more sections. The work stage supporting the blade traverses automatically in a vertical plane



Tracer rollers are shown in contact with root section of the blade and the scribing tools mark blade profile upon coated glass plate. Also shown are unscribed and scribed plates. Table automatically rotates clockwise, synchronized with tracing arms, scribing cutters and blade indexing

GREATLY increased production and development schedules demanded for jet aircraft engines have necessitated faster and better methods for inspection of their critical turbine blades and compressor vanes.

A jet engine may have anywhere from 800 to 1500 blades. Turbine blades may vary in size from less than one-half inch to more than six inches in length. Some are twisted, some are tapered at the tip and most are thinner on one edge than on the other—every one a miniature airfoil. Inspection is important because one defective blade may throw a whole turbine disastrously out of balance.

With typical American ingenuity, a company not directly concerned with blade manufacture visualized the need and drew on its wide experience in optical-projection inspection methods to produce a comparator which provides the highest degree of accuracy—with speed compatible with production in-

spection and which keeps a permanent record of each blade processed.

The *Pant-O-Scriber* Blade Checker of the Engineering Specialties Division, Buffalo, N. Y., is an automatic machine which was developed and proved under production-line inspection conditions, working with one of the leading gas-turbine manufacturers. Its operation was clocked at 43 seconds for a three-section blade, and blades were completely checked for contour, twist, thickness, width and other specifications in less than one minute. A permanent inspection record of each blade is obtained at the time it is inspected.

The *Pant-O-Scriber* automatically traces the blade at the sections to be checked, (usually three sections) and a co-ordinated rotating scriber produces a duplicate tracing on an especially coated glass plate. The sections are scribed on the glass plate in accurate relationship to the edge of the glass and to each other.

A precision master inspection chart,

actual size of the blade, is used with the scribed plate for inspection purposes. The scribed plate and the inspection chart are placed face to face in a predetermined registered position and their images projected in any desired size on a white screen, using a standard, vertical lantern-slide projector.

For production inspection purposes, a "go and no go" *Bridge Tolerance Chart* is used. This chart is precision made to the size and section spacings of the blade. Permissible tolerances are shown on the chart as a series of alternate red and white "bridges"; the outsides of the bridges are connected by a wide red band.

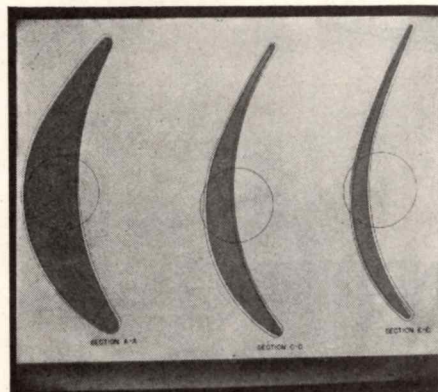
When an acceptable blade is viewed on the projection screen, the operator sees a series of white "windows" created by the contrast of the green scribed blade profile and the red "go and no go" bridges of the tolerance chart. The windows of light must appear within the bridges, and any "off-tolerance" condition is easily discernible. The scribed plate may be retained as a permanent inspection record of the blade, or a microfilm record of the projection screen can be made. The scribed glass plate may be recoated and used again and again.

How It Works

The basic mechanism of the *Pant-O-Scriber* utilizes an adjustable and interchangeable roller, having a 0.250 in radius, attached to one end of an arm, on the opposite end of which is incorporated a motor-driven, free-floating, rotating spindle. This spindle carries a single "flytool" type of scribing cutter head. This cutter rotates in

circles which are exactly the same radius as the tracer roller. Two such arms are employed, one for following each side of the blade.

As the rollers move across the blade in the X plane, the motor-driven scrib-



Scribed blade contour checked against master chart. Profiles must be within double contour lines for blade to be acceptable

ing cutter duplicates the movements and, in so doing, cuts or "scribes" the green film from the glass. The rollers and scribing cutters are positioned so that the tracer roller and scribing cutter of one are ahead of the corresponding units of the other arm.

Profile Likeness

This enables the tracer rollers to travel sufficiently around the leading and trailing edges of the blade for scribing a true profile of these edges during its operation. The arms are also mounted on a cross beam in the Y plane and this pre-loaded assembly provides an accurate duplicating free movement of the tracing rollers and the scribing cutters in the X and Y planes.

As the blade is indexed to the second and third gaging positions, the *Pant-O-Scriber* glass also moves a known distance and the next sections of the blade are scribed on the same glass.

A special measuring stage, which fits over the lanternslide projector, is supplied for engineering and research purposes. This stage is used to measure the amount of deviation of twist, displacement, thickness, contour profile and other variables when desired.

Records have been made with the *Pant-O-Scriber* of blades prior to assembly in jet engines. After periodic test runs of 25 hours or 50 hours, the same blades were again put through the blade checker and the scribed profile compared with the master inspection chart and records retained. Similar records showing the effect of high temperatures and other factors on blades are valuable to engineering and

research departments in developing better engine performance.

The blade checker is compact and can be placed on a table for the convenience of the operator. Highly skilled operators are not required.

Three standard models of *Pant-O-Scriber* blade checkers are available, each employing the principles described. Model 300 is automatic and

A special *Pant-O-Scriber* is available for checking the contours of forging dies. This permits obtaining a record of the dies, and comparison can be made with the forged blade for inspection and charting purposes. A study of die wear with resultant better control is also possible. There are other special applications to which this equipment can be applied including

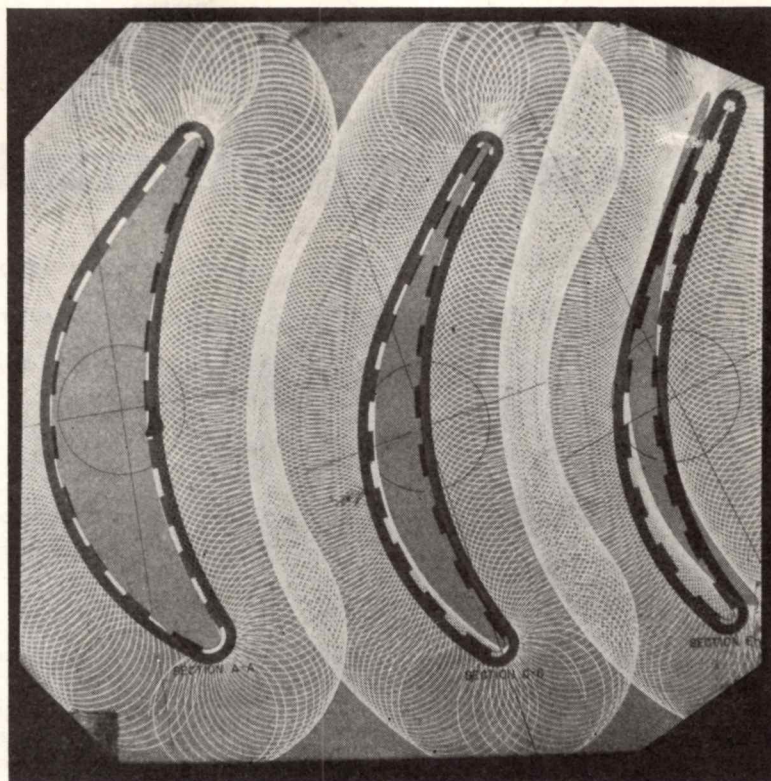


Photo of screen showing the effects of blade distortion after test-running of an engine for 25 hours. Background shows scroll action of revolving scriber tool which produces a clean edge around the profile. Scroll effect can be removed

is used for three-section production inspection of blades; Model 325 is automatic and used for production inspection of unfinished or finished blades, checking two sections simultaneously; and Model 350 is partially hand-controlled, specially designed for engineering and research development purposes, master pattern makers, vendors, and tool-room use.

checking cams, propeller blades and airfoil models.

Engineers Specialties engineers are specialists in the field of optical-projection inspection methods. They have designed and built numerous inspection fixtures and precision-chart gage screens for use on optical comparators and projectors, simplifying many complicated inspection operations.

"Tailored" Regional Air Service

A PROPOSAL for airline service to industrial and resort centers in northern New England and northeastern New York has been submitted to the CAB by R. B. C. Noorduy (Norseman designer), president of Yankee Skylines, Inc.

The route pattern would converge three routes from New York, Boston and Syracuse at Rutland, Vt. Morning passengers from terminal points would arrive at Rutland at about the same

time and could transfer there to planes going to other points.

The airline would not be a feederline but rather a regional air service fitted specifically to the needs of the population served. In addition to the larger cities served, the service would supply the air travel needs from Portland, through Montpelier and Plattsburgh and points between. This concept has been used successfully by Robinson Airlines, in the Ithaca, N. Y., area.

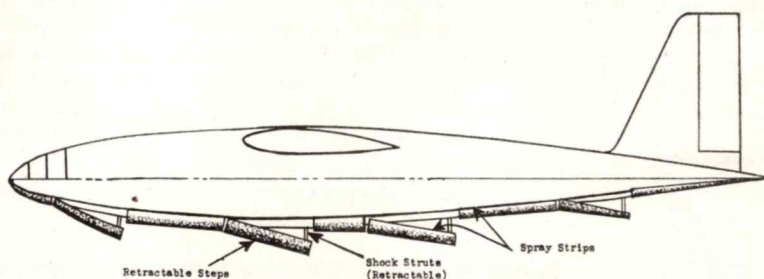


Figure 1

AIRPLANE FOR WATER LANDINGS

A designer's investigation based on the concept of a landplane afloat rather than that of a boat that will fly

LT. ALFRED B. HERB*

*Airframe Officer, Maintenance Dept., Aircraft Development, Squadron Two
Naval Auxiliary Air Station, Chincoteague, Va.*

AT THE outset, it is conceded that it is possible, perhaps even probable, that the suggestions offered here may have been proposed, before and proved to be without merit either by theoretical or experimental means.

*Opinions expressed in this article are the author's and are not to be construed as reflecting views of the Navy Dept. or the Service at large.

However, it is assumed that they have not been so proved.

This design "engineeering" begins its line of attack not by suggesting a boat that will fly, but rather suggesting an airplane that will alight on water.

The basic hull form selected is a fuselage such as is used on the Repub-

lic *Rainbow*, wherein there is no departure from a true streamline shape. Into this basic streamline form, an attempt will be made to incorporate retractable steps which will absorb shock loads during landing and take-off, in addition to performing their primary function of providing planing surfaces to produce lift while moving through the water.

It is suggested that four retractable steps be used. Two main steps will be located so that their longitudinal centers of lift will be equidistant fore and aft of the center of gravity of the airplane. One auxiliary step will be located near the bow to protect the hull from rough water damage. The other auxiliary step will be located about two-thirds of the distance from the rear main step to the aft end of the fuselage. This after auxiliary step will be incorporated to prevent hazardous landings.

The length of the main steps would be approximately 10% of the hull length. Laterally, the steps will include about 70% of the lower circumference of the hull. The two auxiliary steps will be about 8% of the hull length for their longitudinal dimension and also 70% of the lower circumference of the hull laterally. The outer skin of the steps conforms with the outer contour of the hull when retracted for flight.

The steps will be set into watertight recesses constructed into the hull bot-

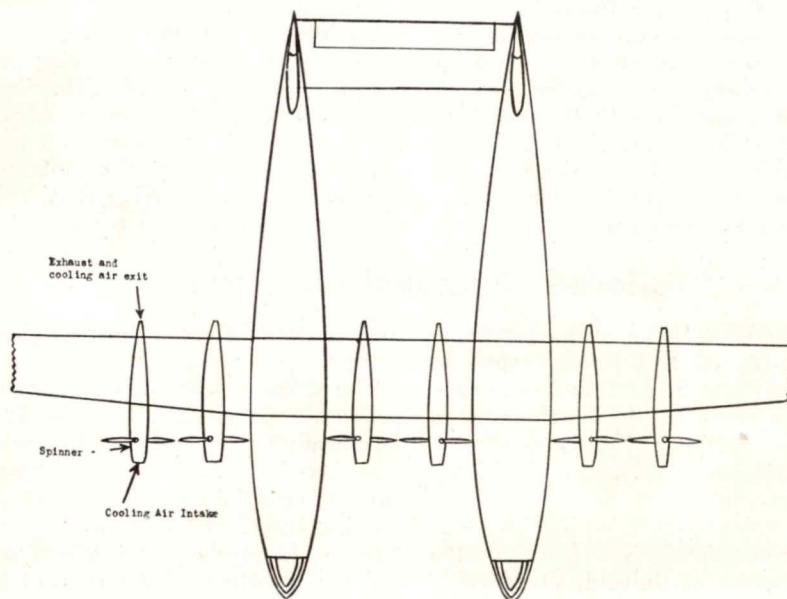


Figure 2

tom and their leading edges attached to the hull by two hinges. The trailing edges are to be supported by two hydraulic shock struts of conventional design. Hydraulic retracting cylinder and piston assemblies will be incorporated into the upper end of the struts. The struts will be mounted within tubes, closed at their upper end, which will be assembled to the framing and skin over the recesses in the hull bottom, thereby obviating the necessity of extending the struts through watertight seals.

Each step will incorporate a spray strip along its outer edge. The cross-section of the spray strips will follow an extension of a radial line 35° from the bottom centerline of the hull. Spray strips will be mounted also on the hull between the steps and will form continuous strips while the steps are retracted. The strips will run fore and aft along the hull surface and will of

design satisfactory retractable wingtip floats. To date, it appears to be almost a losing battle, with the *Catalina* design the only contender in the field. As long as this class of aircraft is being built in the medium-size range, no doubt retractable floats could be used to advantage.

However, in craft the size of the Hughes flying boat for example, it would seem better that two hulls be used, with two of the engines mounted on the wing center section between the hulls. The twin-fuselage idea appears

view. *Fig. 3* shows the front elevation with front retractable step in extended position.

Fig. 4 shows the suggested engine nacelle design. One variation from designs already in use is the use of a spinner which follows the contour of the engine nacelle. The spinner is mounted onto the propeller blades by split disks which are free to rotate in bearings to allow propeller-pitch changes. The spinner is supported by the propeller.

It is considered that this design will reduce drag of nacelles and of propeller-blade shanks as the thick sections of propeller blades are entirely within the spinner where they are exposed only to low-velocity air. Use of five-bladed propellers will reduce diameter, thereby increasing the water clearance. This five-bladed design will probably not result in any loss of efficiency, as no blade shanks are exposed to the air stream.

Fig. 5 shows a step with the attached retracting struts. Rear view shows position when retracted into the hull.

The author, along with many others, believes that seaplanes can be good airplanes, but believes that that can be true only if they can equal landplane performance. It appears a large order to approach the speed of the Republic *Rainbow*, for example; therefore, the only way to make a "good" seaplane is to make no greater compromises to drag than the amount of such compromises found necessary on landplanes. The seaplane design described here, if proved practical, no doubt could equal landplane performance.

necessity be of considerable strength.

The angle of step setting with the shock struts uncompressed and the retracting struts extended is an item that has to be determined experimentally.

During flight, the only compromise from a streamline form will be the spray strips. However, as long as the hull is moving parallel with the air-stream there will be no cross-flow of air over the spray strips; therefore they will offer little drag.

It can be argued that the above arrangement will offer fewer structural design problems than would be encountered in displacing complete hull sections as advocated by Daniels.[†] In this latter design, there remains the V-bottom which is a departure from the best streamline form. With the use of steps supported by shock-absorbing struts, the elimination of the V-bottom becomes a possibility.

Designers of seaplanes evidently must spend much thought in trying to

to be a great success in the P-32 *Twin-Mustang*. The advantage of decentralizing the load on the wing should result in a considerable saving of weight along with the primary advantage of eliminating wing floats.

Fig. 1 shows the side view of the hull with the retractable steps in extended position. *Fig. 2* shows the plan

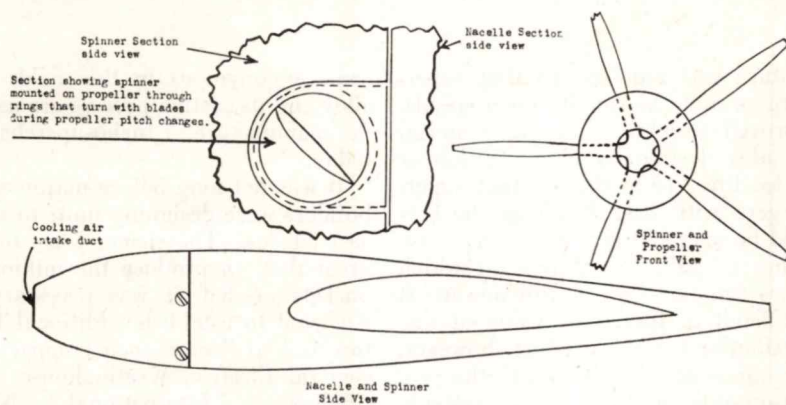


Figure 4

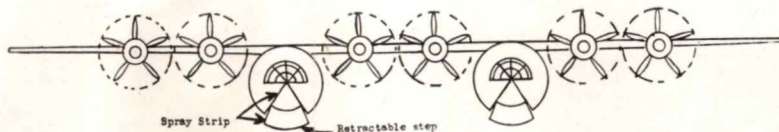


Figure 3

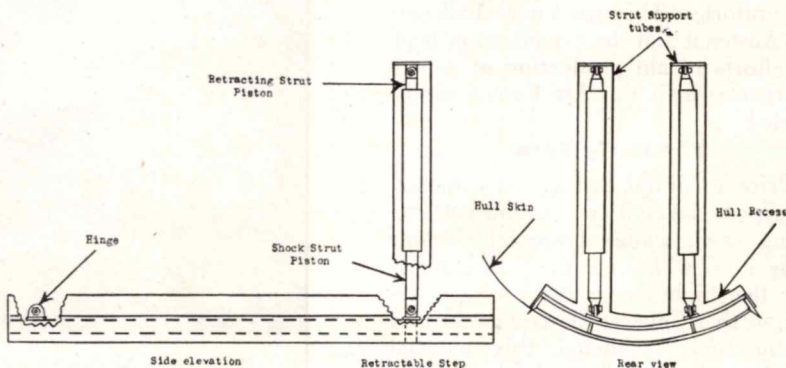


Figure 5

[†]Daniels, Charles J.; *Seaplanes Can Be Good Airplanes*; AERO DIGEST Feb. 1948, P. 38.

Teeth for the Jets

R. L. WISEMAN
Austen Laboratories, Inc.



THE dental industry may seem far removed from aviation activities, yet truth is stranger than fiction—there is a dental technique providing key parts that have literally put teeth into gas-turbine powerplants.

As part of the outstanding job accomplished by the major aircraft-engine builders, the share played by smaller companies in related, specialized fields has contributed mightily to prove the cooperative teamwork of American industries. The "little giants" of industry play their part in producing the end product and their contribution to aviation cannot be minimized.

Although not breaking into the headlines very often, the specialists of various small industries have developed techniques to allow the engine manufacturer to produce a better end product. Even though a considerable number of turbine blades is still produced by forging and machining methods, a new industry has been brought to the front within the past seven years—that of precision investment castings.

Early in 1941, General Electric, while seeking a better alloy and a means to increase its capacity for producing supercharger buckets—in an effort to break a serious bottleneck caused by a lack of forging facilities and machine-tool equipment—approached Austen Laboratories. This was a new challenge for Austen and the organization bent all efforts to aid production of superchargers which the Air Forces sorely needed.

The Early Form

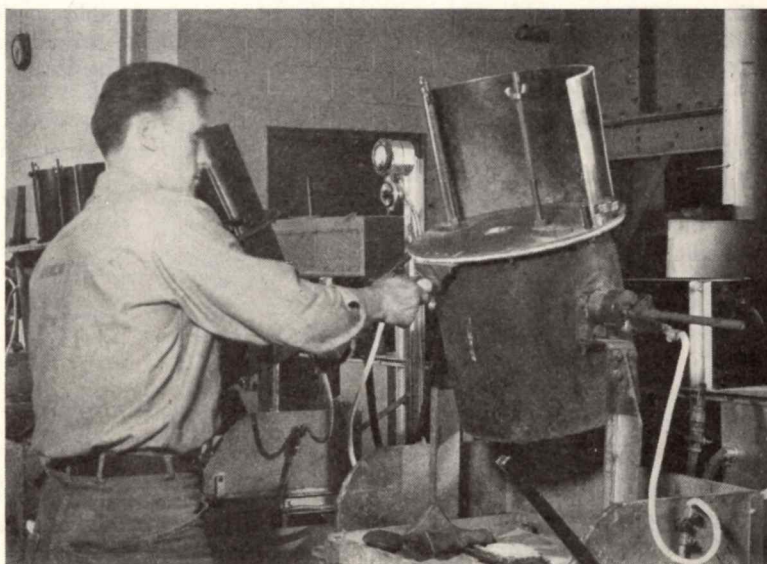
Prior to initial casting experiments, a forged, dovetail type of bucket was being used, made of special *Cyclops* alloy 17W, which was the best material for the high-temperature service required that General Electric could find at the time. Although this material would withstand the stresses imposed at standard rated speeds, a new alloy with greater strength at elevated tem-

perature was required so that superchargers could be run at higher speeds. Improved strength of bucket material was also desired to obtain a longer service life. Tests showed that superchargers with cast *Vitallium* buckets could be operated at higher speeds, resulting in gains in altitude at which planes can be flown at full power. It is difficult to judge the value of this contribution to the war effort; however, indications are that its aid to the production of turbosuperchargers was substantial.

The solution proved so successful that bucket casting and *Vitallium* be-

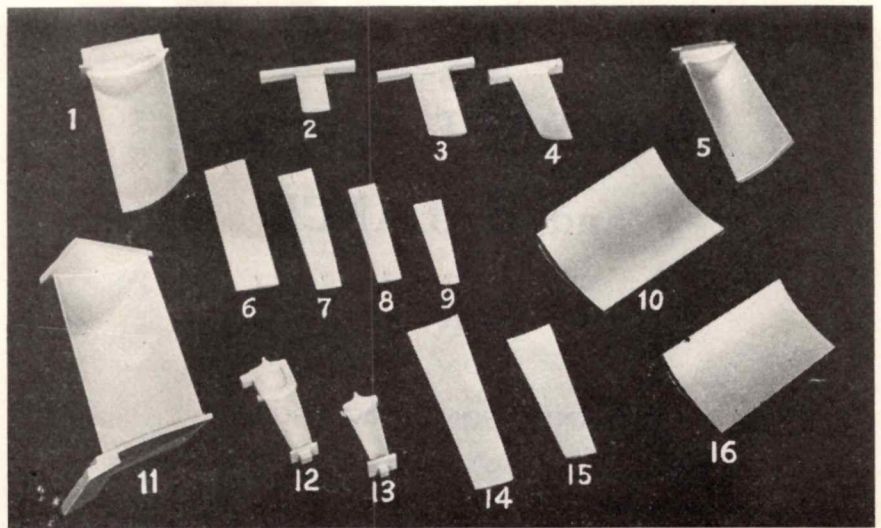
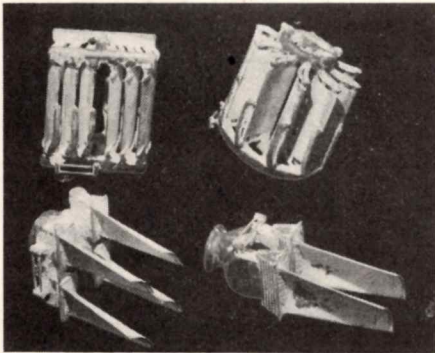
came synonymous in this field. The alloy and its casting process are used in the manufacture of turbosuperchargers today.

It was not long before major engine builders were designing units to utilize cast blades. The demand became so great that, to produce the millions of buckets needed, it was necessary for Austen to establish additional facilities and to license such companies as General Electric, Westinghouse, Allis-Chalmers, International Nickel, Haynes-Stellite and Michigan Steel. Once again small industry proved its worth by training representatives of



Pouring of the molten metal is done, under pressure, into hot molds to assure the specified density and finish of the completed piece. Small carbon-arc furnaces are employed; the flask is clamped to the top of the furnace and the assembly is inverted for casting

Clusters of "Micro-cast" jet blades and buckets as they appear after the refractory material has been removed. The castings are cut free, cleaned and finally inspected



Typical cast pieces for jets and superchargers: (1) J-33 turbine bucket; (2), (3), (4) TG-100 compressor blades; (5) J-34 turbine blade; (6), (7), (8), (9) J-30 compressor blades; (10) J-47 nozzle blade; (11) J-42 nozzle blade; (12) CH-7 supercharger turbine bucket; (13) BH supercharger bucket; (14), (15) J-34 compressor blades; (16) J-35 nozzle blade

its licensees and passing along the "know how" that had been accumulated over the years.

Austenl started in 1928 as a two-man dental laboratory in a small loft in New York City. Through research and development by the founders, Reiner W. Erdle and Charles H. Prange, a new method of producing dentures was perfected, and simultaneously a new cobalt-base alloy (*Vitallium*) was created. *Vitallium* is a cobalt-chromium-molybdenum alloy with a melting point of approximately 2500° F.

With the new alloy it was necessary to devise a method of casting such a high-temperature metal. To attain this end the "lost wax" process was revived and improved upon. Thus, from swaging stainless steel alloys the designers converted their dental business to cast *Vitallium* dentures. From a small beginning it soon became necessary to license approximately 225 dental laboratories all over the world.

Widening Service

A few years later surgeons recognized the possibilities of *Vitallium* for the surgical field. This proved a boon, particularly during World War II, when large amounts of surgical plates and screws for fixations of bone fractures were utilized in surgery performed on wartime casualties.

Steps were taken also to adapt the technique to industrial use. All previous experience was put into play and a means of producing industrial castings developed. The idea of casting bronze images from wax models dates back to the time of Cellini in the 16th century.

To produce a blade by the casting

technique, called the *Microcast Process*, it is necessary to construct a master pattern or model in metal, such as brass or steel, by conventional machining methods. The shrinkage factor must be taken into consideration inasmuch as a split die or mold is cast over the master. Wax is injected into this mold under pressure and the wax patterns are assembled to gates and sprues in a precalculated pattern. Clusters of wax patterns are coated and embedded in a refractory investment material and joggled until the refractory material settles about the patterns.

The flasks are then inverted on a steam table and the wax melted out, leaving the cavity undisturbed. After air drying, the flasks are sent through a baking oven under constantly rising

temperature. The molds are poured while hot to assure fluidity of the metal which is cast under pressure at a temperature well above its melting point.

Furnaces

For the most part, small carbon-arc furnaces are employed and pouring is accomplished by clamping the red-hot flask to the top of the furnace and then inverting it. This particular type of furnace was developed and patented by A. W. Merrick, chief metallurgist of Austenl. Stripping from the flask is done by power and particles of investment clinging to the castings are dislodged by tapping with a hammer. The castings are then cut from the clusters and are ready for inspection and ultimate shipment.

The development of *Vitallium* and the *Microcast* process was recognized formally when the National Association of Manufacturers gave a Modern Pioneer award to C. H. Prange for distinguished achievement in the field of science and invention.

The record production of one of the first American-designed jets, the J-33, which today powers Lockheed's F-80 *Shooting Star*, was greatly aided by the fact that it was possible for Austenl to cast *Vitallium* turbine buckets. Thousands of these buckets are being utilized exclusively on this engine.

Jet-propulsion design progressed, and metallurgists and engineers explored the field of alloys to determine those which lent themselves most readily to casting. Out of this survey came cast compressor and turbine blading for such engines as the GE-Allison J-35, General Electric's TG 100

(Continued on page 90)



Charles H. Prange

AIRCRAFT WEIGHT and BALANCE

PART 1

M. C. ANDERSON & J. W. ROCKE*



Figure 1

THE subject of weight and balance is important from the standpoint of safety, economy and efficiency. An improperly loaded airplane, at best, will fly slower and consume more fuel; at worst, it may be the cause of an accident. The pilot should understand the principles of weight and balance to protect himself. The mechanic must be familiar with procedures to handle the work which comes into his shop. Far from being a difficult subject, weight and balance can be understood by anyone familiar with aircraft terms and who can work problems in simple arithmetic.

Almost everyone at some time has solved the weight and balance problem sketched in *fig. 1*. The airplane, in balance (*fig. 2*), acts like the seesaw. Balance is secured by placing the various loads at the correct distance from the pivot, or center of gravity.

When the mass load of the aircraft is placed too far forward of the balance point (*cg*), a nose-heavy condition is created which causes several undesirable characteristics. Increased fuel consumption shows itself in that more power is necessary to maintain the air-

craft in a level-flight attitude. The pilot finds that such loading tends to increase dive conditions beyond control. It is possible that trim-tab range will be insufficient to produce a level-flight attitude, with the added possibility that the surface controls may be unable to control the aircraft safely in some attitudes, most prevalent at the time of landing.

If the aircraft is a tricycle-gear type there is the danger of overstressing the nose-wheel. If the plane is equipped with landing flaps, the nose-heavy condition will become critical during flap operation. It may even bring about a situation in which the surface controls do not have sufficient range of movement to prevent a loss of altitude.

If the load is placed too far aft, the aircraft will tend to stall more readily. Low power settings for cruise economy are definitely limited. Speed will be decreased by the increased drag caused by control action to prevent the nose-up tendency. This increases the strain on the pilot and unnecessarily overloads the tail structure.

Fuel consumption will be increased by the increase in drag. In extreme overload conditions, the pilot may not be able to trim the airplane by using the tabs; possibly the condition cannot

be offset even by use of the controls without increasing drag to the extent that airspeed drops dangerously near the stalling point.

Overloading the aircraft raises the stalling speed and reduces maneuverability. All airplanes are built with a strength-safety factor, but with the structure overloaded this safety factor is greatly reduced, especially during rough landings or in rough air. The take-off run will be lengthened, perhaps to the point of being dangerously long if the field and runways are short or have border obstructions.

Overload Penalties

Overloading lowers the aircraft's ceiling and decreases climb performance. Rate-of-climb may determine whether or not an airplane clears field obstructions after take-off. Overloading will cause increased fuel consumption. On long flights, especially on large aircraft, an increase in fuel consumption may be serious. If the flight is successfully completed, the overload condition may still overstress the tires and landing gear upon landing and result in a groundloop.

When the aircraft is correctly loaded, it will provide all the advantages claimed for it. The pilot finds that speed and maneuverability are as specified. No part of the airplane structure is overstressed during any normal flight condition, and the safety factor is at its highest. A correctly loaded aircraft is a safe aircraft.

Weight - and - balance procedures bring a special terminology. Here are the terms and their definitions:

Weight.—All weights are avoirdupois, 16 oz to one lb, usually carried out to the fraction of a lb.

Basic Weight.—Weight of the airplane including items of equipment that have a fixed location and are normally present in the airplane. Such weights include the airframe, powerplant and

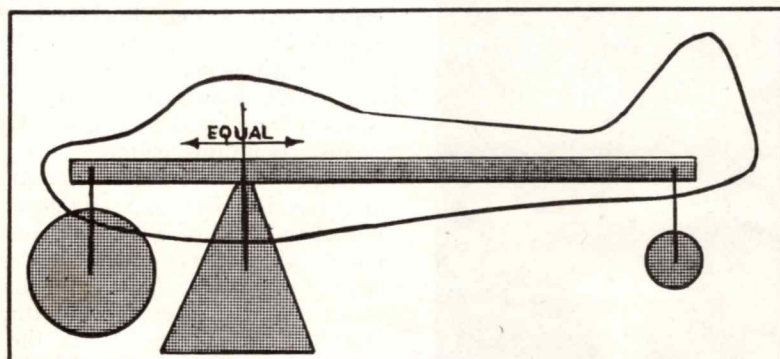


Figure 2

*Co-authors are A & E mechanics and A & E ground instructors.



accessories, fuel and oil in sumps and lines, full cooling, hydraulic and anti-icing systems and reservoirs, chemical, navigation, oxygen, flares and radio equipment. Basic weight never includes items that are disposable or items that are not always carried on the airplane.

Gross Weight.—Total weight of the aircraft and its contents such as fuel, oil, pilot, passengers and cargo. The term *gross weight* is sometimes used to indicate the maximum allowable weight.

Datum Line.—An imaginary line (vertical) chosen by the manufacturer as a standard line from which all horizontal measurements are taken for balance and construction purposes. Usually located at the nose of the airplane or at the leading edge of the wing. Is used as a reference, or zero, line from which all measurements are taken.

Arm.—Distance measured in inches, from the datum line to the item involved, or the location of the item involved.

Moment.—The result of multiplying the weight of an item by its arm. Moments are always expressed in *inch-pounds*.

Basic Moment.—Sum of the moments of all items making up the basic weight. When using data from an actual weighing of an airplane, the basic moment is the sum of all the moments around the datum line.

Total Moment.—The result obtained by adding to or subtracting from the basic moments of items added to or removed from the airplane.

Center of Gravity (cg).—The point about which an airplane would balance in its normal flight position if suspended from a single cable. Its distance from the datum line is found by dividing the total moment by the total weight of the airplane.

CG Limits.—Range of movement which the cg can have without making the aircraft unsafe to fly. The cg must be within these limits at takeoff, in the air, and on landing. Measurement of cg limits is always expressed in inches from the datum line or in per-

cent of the mean aerodynamic chord.
Tare.—Weight of equipment necessary to hold the airplane on the scales when weighing it; must be subtracted from the scale readings to obtain true airplane weight.

Mean Aerodynamic Chord (M.A.C.).—The chord of an imaginary airfoil which would have the characteristics of the airfoil in question. Is also used in aerodynamic computations.

Leading Edge of Wing (L.E.W.).—Sometimes used as a measuring point. The leading edge of the wing reference point is usually taken at the root section of the wing.

Equipment, Class I.—Required equipment installed in the airplane at all times, so the aircraft will be deemed airworthy from all standpoints.

Equipment, Class II.—Optional equipment from the standpoint that such item may be substituted for or replaced by a similar item of different manufacture. Class II equipment becomes a part of the aircraft once it is installed. May include items like propellers, tires, generators, etc. Class II also includes items that may not have been originally installed on the aircraft but can be if so desired. Installation or removal of Class II equipment necessitates a weight-and-balance check to ascertain that approved cg limits are not exceeded under the most adverse loading conditions possible. Installation or removal requires inspection by a CAA inspector.

Equipment, Class III.—Again optional equipment, which when installed will not affect the balance of the aircraft. This would be the case if the item were to be installed between the cg limits. If the same item were installed elsewhere, the cg would be affected and the item automatically becomes Class II equipment. Installation or removal of Class III equipment does not require inspection by a CAA inspector but does require a weight-and-balance computation.

Forward CG.—Most forward point to which the cg may move and still be within the cg limit. Measured in inches from the datum line, or in percentage of the M.A.C.

Aft CG Limit.—Most rearward position to which the cg may move if the airplane is to remain safe to fly. Also measured in inches from the datum or in percentage of the M.A.C.

Ballast.—Weight that is added or removed from the airplane to maintain the cg within the approved limits. This weight has no use except for balance purposes.

Minimum Fuel.—The least amount of fuel with which the aircraft may take off and still be considered safe to fly—used for balance computations as equaling $1/12$ gal per maximum (except takeoff) hp. Minimum fuel in gal is computed as $\frac{\text{total hp}}{12}$.

imum fuel in lb is computed as $\frac{\text{total hp}}{2}$

Standard Weights.—Used for balance computations.

Plot and/or passengers.....170 lb each
Fuel6 lb per gal.
Oil7½ lb per gal.
Baggage as per maximum amount placarded in the baggage compartment.

Positive Arms.—All arms (distances) measured aft or to the rear of the datum line.

Negative Arms.—All arms (distances) measured forward of the datum line.

Positive Moment.—Any moment that results in a tendency toward a tail-heavy condition, or moment acting aft of the datum line.

Negative Moment.—Any moment acting forward of the datum line so as to produce a nose-heavy condition.

Compensating Weight Changes.—Computing balance by adding or removing ballast to compensate for addition or removal of weight from the airplane. Such change supposedly does not change the original cg position.

Aircraft Specifications.—Bulletin published by the CAA which gives complete specifications and information relating to manufacture of a specific aircraft, including type and location of equipment installed, weights, measurements and powerplant. Used as a reference to assist in weight-and-balance computations. Available from the CAA for any aircraft of American manufacture.

CAA Form 309.—Lists all pertinent operational data relating to the complete aircraft. Includes operational speeds and limits, equipment installed complete with weights and arms, all information relating to datum line, cg limits, fuel and oil tank capacity and location, etc.

CAA Form 337.—Repair and alteration form that is filled out and submitted to the CAA inspector upon completion of a major repair or major alteration. Such form includes a detailed report, including drawings and computation, of the actual repair work done on the aircraft. Form 337 and the repair must be approved by the CAA before the aircraft is deemed airworthy.

In the airplane, the fulcrum of *fig. 1* becomes the cg, while the fuselage itself acts as the plank. Since the cg is always near the forward part of the wing, heavy loads near the wing may be balanced by much lighter loads in the nose or tail. Large changes in weight along the lateral axis are not possible. The manufacturer constructs the airplane to balance laterally by building the same number of fuel tanks and other equipment into each side. In service, therefore, it is only necessary to check horizontal balance.

The datum line may be located at the nose of the fuselage. Then all the arms are measured in one direction only—aft—and are all known as plus

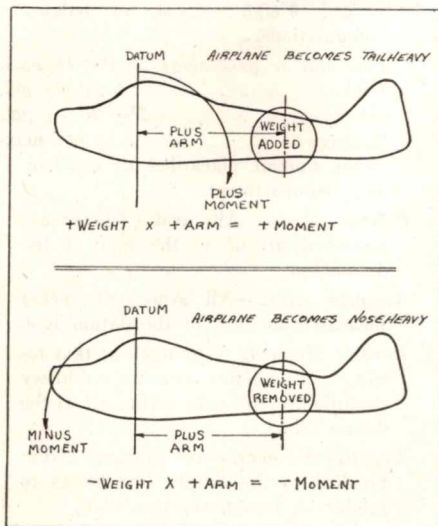


Figure 3

or positive arms. If the datum line is located at the wing leading edge, or at some other intermediate point on the fuselage, the distance to various loads will be measured both forward and aft of the datum line. Arms forward of the datum are known as *negative* arms and those aft of the datum line are known as *positive* arms.

In order to obtain the gross weight and the *cg* location of an airplane, it is necessary first to know the weight empty, and the *cg* position with the airplane empty. This may be found by actually weighing the airplane on scales. When the weight, arm and moment of the empty airplane are known, the effect of the various loads such as fuel, crew and cargo may be easily computed. This is simply a matter of finding a new *cg* for the airplane when it is carrying all these additional loads.

It may be done by simple arithmetic or, more often, when time is a factor, by a computer resembling a slide rule. Since these computers vary widely in construction and usually apply to one specific aircraft only, no attempt will be made to cover them here. Only the mathematical method will be described.

To find the *cg* of an airplane, the total moment of all the loads about the datum line is divided by the weight of these loads. The result is the arm of the aircraft weights, or the *cg* of the airplane measured in *in* from the datum line. This would be the fulcrum of the seesaw. If this *cg* does not fall within the fore and aft limits (previously de-

termined by flight test at the time of manufacture) the load must be shifted to bring it within these limits.

On an airplane, the wing supports the weight in flight; therefore the *cg* must remain near this point or the tail surfaces will not be capable of controlling flight. This sometimes makes necessary the addition of ballast to prevent the *cg* from going out of limits when a new piece of equipment is added. Thus, if a radio is added in the rear of the fuselage, a lead weight may be required on the nose cowl.

Measurements, or arms, forward of the datum line are negative (-); arms aft of the datum line are positive (+). If a weight is added to the aircraft, it becomes a plus (+) weight; if a weight is removed, it is subtracted and becomes a minus (-) weight. Thus it is seen that the sign preceding a measurement indicates its location or its effect upon the airplane.

A sign preceding the moment is also used to indicate the direction in which the moment acts. Thus, a plus (+) moment is one acting to the rear, or making the airplane tailheavy; a minus (-) moment is one acting toward the front, making the aircraft noseheavy. (See *figs. 3 and 4*.)

Because a sign is used to indicate a direction of measurement, the *cg* is expressed as a plus (+) or minus (-) measurement to indicate its direction from the datum line. This is true of all measurements taken on the aircraft. If it is said that the wheels are located at -6 *in*, it is meant that the centerline of the wheel axle is located 6 *in* forward of the datum line. If the *cg* is located at +33.5 *in*, it indicates that the *cg* is 33.5 *in* aft of the datum line.

Following the Signs

When working weight-and-balance problems, the signs preceding the numbers must always be observed when adding, subtracting, multiplying or dividing. The fact that a weight is located at a minus arm does not mean that it will always produce a negative moment, and *vice versa*. Following the laws of signs in the computations eliminates errors in this respect.

Special scales for aircraft are manufactured, but few shops or airports except the larger ones have such equipment. Lightplanes may be weighed on any balance or spring-type scale that has the capacity to take the weight of one wheel. It is entire-

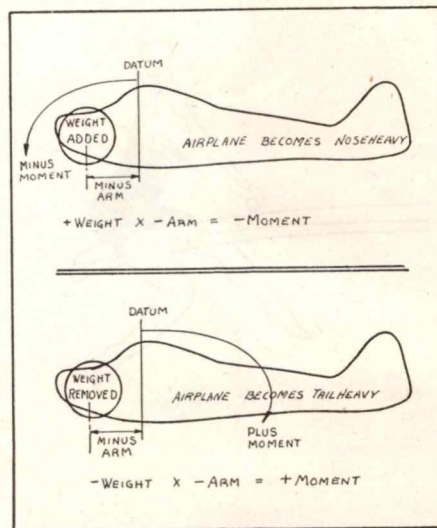


Figure 4

ly possible to weigh an airplane with a single scale, weighing one wheel at a time to find the total weight of the airplane. This method, while acceptable, is not as accurate as weighing each wheel on separate scales, and is a more lengthy process.

All equipment that is not under the Class I, II or III headings must be removed. This would include parachutes, special seat cushions, portable radios, tools, etc. Items such as fire extinguishers or tie-down kits which have special places in the airplane and are carried at all times are left in place. Check the equipment list on Form 309 and make certain that all necessary items are in place.

Fuel tanks must be drained of fuel. Residual fuel which cannot be drawn from the system by the engine is considered as part of the empty weight.

The oil may be drained, or the airplane weighed with the oil in, provided that the tank is filled to capacity. In this case, the weight-and-balance form must state that the airplane was weighed with fuel tanks empty and oil tanks full. After weighing, the weight of the oil may be subtracted from the airplane weight and, by computation, the *cg* for the airplane, less the oil weight, can be determined easily.

It is sometimes easier to do the job in this manner rather than go to the trouble to drain the oil. However, the oil tank is always filled to the capacity stated on the filler cap before weighing under such circumstances.

Hydraulic, coolant and anti-icing systems are not drained; rather, the systems and reservoirs are filled to their stated capacity. The weight of the liquids is not subject to any appreciable change during normal operation, thus not affecting weight and balance to any great extent.

The airplane should always be weighed in a closed building to prevent errors in scale readings due to wind gusts. Even a slight wind may act upon the airplane structure to cause an inaccurate reading.

The airplane is put on the scales (assuming that three separate scales are being used) and then leveled to normal flight position. The manufacturer provides special points (called leveling points or leveling lugs) in or on the aircraft for this pur-

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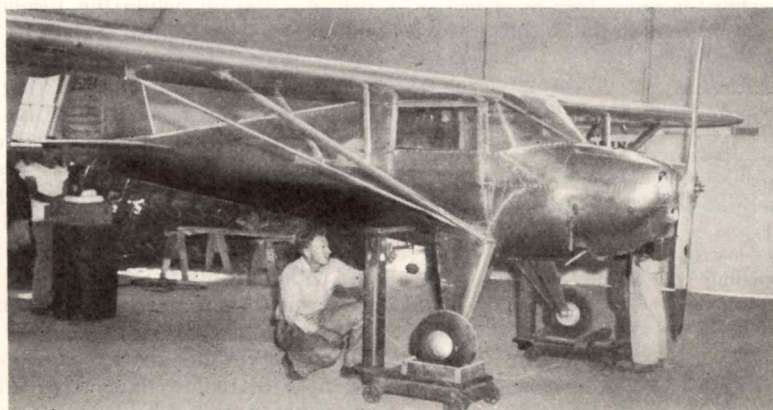


Figure 5

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Low Weight/Horsepower Ratio
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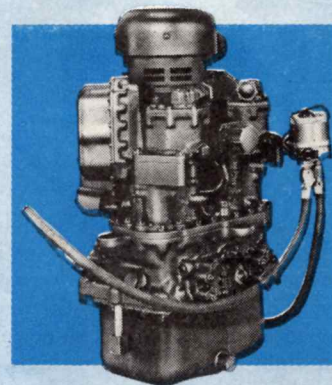
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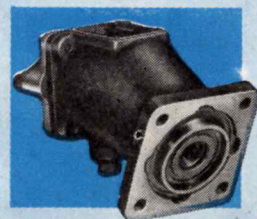
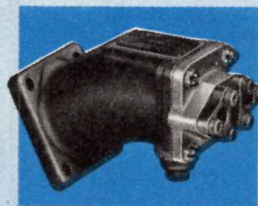
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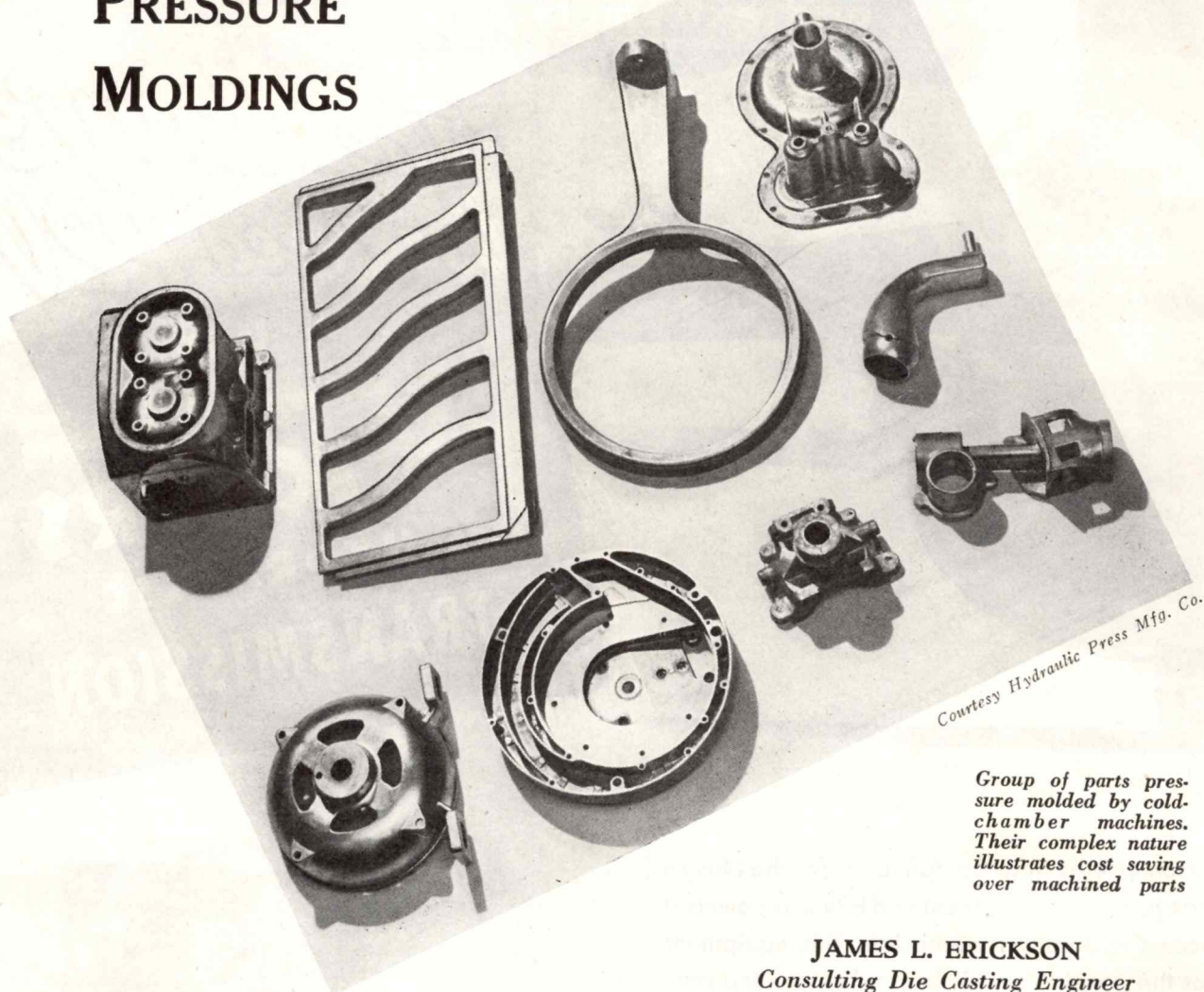


Vickers Double Pump and Control assembly provides complete and independent control of speed and rotation of two hydraulic motors.



Vickers Hydraulic Motors can be stopped accurately to position without clutches or brakes . . . can be started and stopped instantly because of very low inertia of moving parts.

ALUMINUM ALLOY PRESSURE MOLDINGS



Courtesy Hydraulic Press Mfg. Co.

Group of parts pressure molded by cold-chamber machines. Their complex nature illustrates cost saving over machined parts

JAMES L. ERICKSON
Consulting Die Casting Engineer

THE aircraft designer now has at his disposal a comparatively new type of aluminum-alloy casting method which produces castings possessing mechanical properties equal to certain light-metal alloy forgings and comparable with alloyed cast iron and malleable iron. These castings are termed "pressure moldings" and are made by a casting process similar to die casting.

Intricate, complex castings with smooth surface finish and extremely dense internal structures are readily made by this process. Pressure moldings are well suited for applications where the part is to be subjected to relatively high-tensile, impact, or fatigue stresses.

Because pressure moldings are cast with the aid of high-speed, automatic, cold-chamber casting machines and because they require little or no machining prior to assembly, they offer stiff competition to light-metal forgings; gray cast iron, alloyed cast iron, and

malleable cast-iron parts; heat-treated light-metal permanent moldings and sand castings, centrifugally cast light metals; and many types of assemblies built up from stampings.

The need for the lightweight pressure molding available today was felt strongly as early as 1939 by aircraft designers

who were thoroughly acquainted with the shortcomings of ordinary die castings when it came to their ability to withstand impact loading and repeated stressing, as well as with the disadvantages of forgings from a machining cost standpoint.

Designers, however, were forced to

Mechanical Properties	(1948) Pressure Molded Aluminum Base Alloys*	(1948) Pressure Molded Zinc Base Alloys	(1948) Die Cast Aluminum Base Alloys	Sand Cast Gray Irons	Aluminum Base Alloy Forgings	Magnesium Base Alloy Forgings
Yield Strength (in tension by the .25 off-set method) psi	18,000-40,000	30,000-55,000	14,000-25,000	-	30,000-50,000	24,000-30,000
Ultimate Tensile Strength, psi	35,000-55,000	90,000-110,000	30,000-42,000	20,000-45,000	36,000-65,000	37,000-45,000
Elongation, % in 2"	8-20	6-10	1.8-7.0	N11	5.0-16.0	8.0-16.0
Charpy Impact, ft. lbs. $\frac{1}{2} \times \frac{1}{2}$ in bar	5.0-14	20-30	2.0-10.0	-	-	-
Shearing Strength, psi	30,000-39,000	77,000	21,000-30,000	25,000-80,000	-	-
Endurance Strength, psi	20,000-27,000	-	17,000-20,000	-	-	-
Physical Properties						
Specific Gravity	2.54-2.88	7.47	2.53-2.70	7.00-7.70		

* Erickson, James L., "Structurally Sound Cast Parts Provided by Aluminum, Base Alloy Pressure Molding," *Steel*, May 3, 1948, pp. 98-100.

Comparison of mechanical properties of various alloys cast and

use forgings in place of ordinary die castings wherever stress reared its head, for die castings were too porous and non-uniform in quality to be relied upon. Merely "beefing up" a proposed part to give it supposedly greater strength and then die-casting it was out of the question, because this did not eliminate the dreaded, dangerous, internal porosity.

Where Designers Stop

When the aircraft designer marked on his print, "To be made as an aluminum-alloy die casting out of such-and-such an alloy in accordance with such-and-such a specification," his recommendations were at an end. From there on out the purchasing department would take over—and here's where the trouble would begin.

The mechanical properties of die-castings received varied from source to source. They tended to vary in performance. Designers found it necessary to design and employ die castings always with a view to the possibility of receiving inferior castings along with the good castings—especially when a given type of die-cast part was purchased from two separate sources. The inferior ones looked the same as the superior ones to the naked eye.

Destructive testing would tell the difference, but destructive testing destroyed the product. Anything but 100% sampling was no good. The result was obvious: designers never took a chance. They knew die castings were not uniform. As a consequence, the quality producer suffered with the inferior producers.

Engineers interested in the future of quality die casting recognized (1) that not all of the factors contributing to the variable mechanical properties of die castings were uncontrollable; (2) that with the proper technique, equipment, and quality control, uniformly high-strength die castings could be produced—that such die castings were being produced; (3) that existent spec-

Chemical Composition	Die Castings (1942) ALLOYS			Pressure Moldings (1942) ALLOYS		
	43	13	356	43	13X	356
Si	4.5-6.0	11-13	6.5-7.5	4.5-6.0	10-12.5	6.5-7.5
Mg	0.1	0.1	0.1	0.05	0.05	0.4
Ni	0.5	0.5	0.5	-	0.05	-
Zn	0.5	0.5	0.5	0.10	0.10	0.10
Cu	0.6	0.6	0.6	0.10	0.15	0.2
Fe	2.0	2.0	2.0	0.80	0.80	0.60
Sn	0.1	0.1	0.1	-	0.05	-
Mn	0.3	0.3	0.3	0.05	0.05	0.1
Al	0.2	0.2	0.2	0.20	0.10	0.2
Other elements	R	R	R	R	R	R
Physical and Mechanical Properties						
(1) Yield Strength in Tension (Set 0.2%) psi	13,000	18,000	15,500	18,000	21,000	18,500
(2) Ultimate Tensile Strength psi	29,000	33,000	30,000	34,000	39,000	35,000
(3) Elongation, % in 2 in.	3.5	1.5	2.5	6.5	4.5	6.0

No. 11347 specification when it was first released early in the war

ifications did not recognize the difference between inferior and superior die-casting techniques; (4) that, as matters stood, designers were prevented from employing the high-quality die castings for hundreds of feasible applications; and (5) that a new specification was in order.

Through their efforts, a new specification, designed to cover the production of top quality die castings, was released. This specification was known as No. 11347, was issued by the AAF on July 1, 1942 and was subsequently adopted in substantially the same form by the SAE and the ASTM.

The specification was specific and tough. It was supposed to be tough. Where the ordinary die-casting specification, AN-QQ-A-366, was vague or loose, No. 11347 was precise and restrictive. First, No. 11347 re-defined the acceptable chemical composition of the various allowable alloys as present

in their final die-cast state. Each of its individual provisos imposed the need for greater foundry control.

It prescribed new mechanical properties and, at the time this specification was issued, these properties were far in excess of those specified for either heat-treated, sand or permanent-mold castings. It also called for strict radiographic inspection of all die-cast parts. Even the type of die-casting machine to be employed (cold-chamber) was stipulated.

The principal limiting characteristics of die castings which this new pressure-molding specification aimed to eliminate were: (1) inconsistent mechanical performance and (2) the relatively low over-all mechanical properties of die castings.

Setting New Limits

The first of these was perhaps the most important because the prime prerequisite to safe aircraft engineering is that the fabrication method chosen to produce a given part shall deliver to the aircraft manufacturer pieces with uniform mechanical properties. Whenever a method produces parts which vary in mechanical properties, the designer is of necessity forced to design his part in terms of the lowest mechanical properties he is likely to find in any of the parts.

Lively discussions arose as a result of the release of the pressure-molding specification, since the specification set forth certain minimum mechanical properties which pressure moldings need possess. These minimum prop-

(Continued on page 86)

Heat Treated Magnesium Base Alloy Sand Castings	Die Cast Zinc Base Alloys	Die Cast Copper Base Alloys	Sand Cast Alloy Gray Irons	Malleable Irons	Die Cast Magnesium Base Alloys	Heat Treated Sand Cast Aluminum Base Alloys	Heat Treated Permanent Molded Aluminum Base Alloys
12,000-22,000	-	-	9,000-19,000	35,500-40,000	-	14,000-35,000	16,000-35,000
13,000-38,000	40,300-47,900	55,000-95,000	30,000-60,000	50,000-60,000	26,000-30,000	21,000-40,000	22,000-55,000
1-11	5.0-5.0	10-20	-	10-25	1.0-3.0	0.5-8.0	1.0-15
-	18-20	33 Min.	-	16.5	1.0-2.0	-	-
-	30,900-45,800	50,000-55,000	-	48,000	-	20,000-35,000	20,000-36,000
			15,000-30,000	25,000-28,500	-	5,500-9,500	6,000-19,500
1.81-1.83	6.6-6.7	8.15-8.47	7.1-7.2	7.20-7.45	1.81	2.66-2.85	2.50-2.68

otherwise formed, at the present stage of pressure-molding progress

Aircraft Yaw Control

CLOYD P. CLEVINGER, who can trace his continuous participation in many phases of aviation back to when the airplane was still in swaddling clothes, has long held the belief that the long fuselage necessary to gain directional stability adds too much weight and drag to an airplane.

He maintains that the ideal aircraft will have a high aspect ratio for efficiency and a short fuselage—without a rudder. Ordinarily, aspect ratio suffers, because the greater the wing span, the longer the fuselage to enable the rudder to produce sufficient torque.

Neither does he believe that the common concept of the “flying wing” provides a fully efficient answer. Yaw control in this case is achieved by introducing resistance at the wing tips. Here, he claims, when drag is increased at one wing tip, there is a loss of lift which upsets the aircraft’s lateral balance.

Clevenger and his brother, Walton, have devised an invention with the broad object of providing a balanced wing-tip yaw control to effect smooth

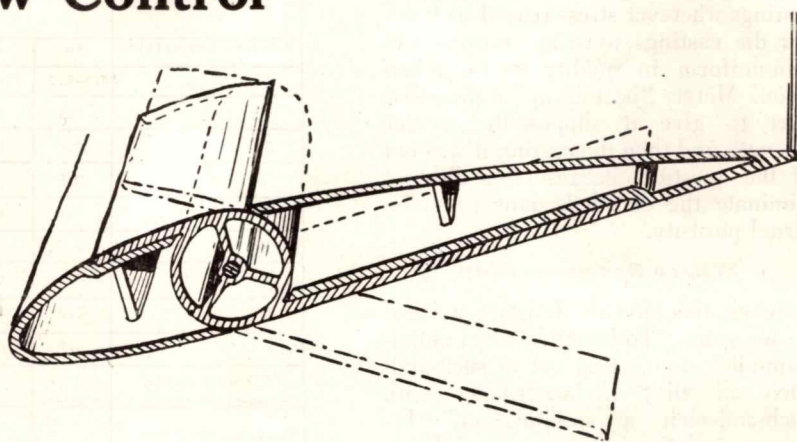
variations in resistance at one wing tip or the other, to yaw the plane to any desired extent, but at the same time avoid affecting the lift of the wing.

They would install near each wing tip—inside the wing—a rotary support, carrying at the upper surface a form of spoiler. On the lower side is a flap. Both units fit snugly into the top and bottom wing contours when inoperative.

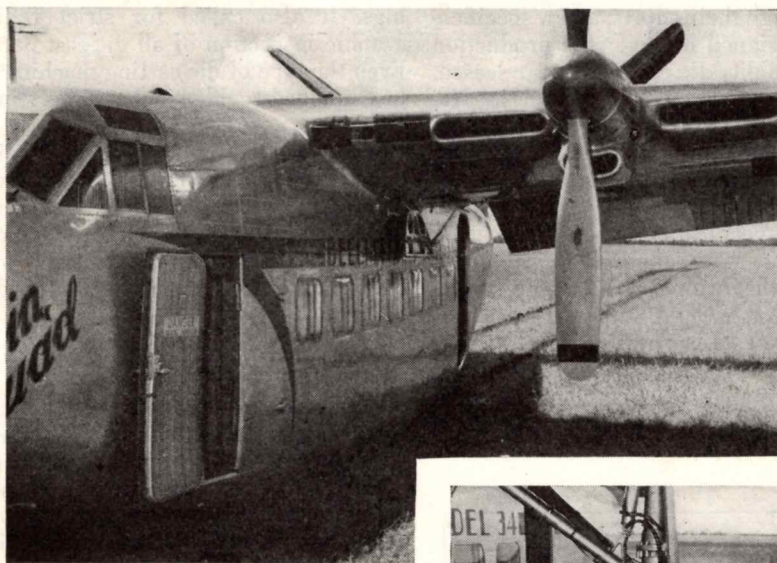
To correct for yaw, the support is

rotated, projecting the spoiler above and the flap below the wing. The major part of the resistance is due to the flap; the increased lift is neutralized by the projecting spoiler which creates burbling. The proportioning of spoiler and flap are such that the net change in lift is zero and yaw-controlling resistance is applied without affecting the lateral stability of the wing.

The Clevenger brothers have been granted Patent No. 2,433,649.



No-Damage Belly Landing



BEECH AIRCRAFT test pilots received an unexpected opportunity to test the emergency landing skids, or “keels,” running along the underside of the flat-bottomed fuselage of the Model 34 *Twin-Quad*, in an unscheduled belly-landing demonstration.

In mid-August, during a routine flight, the plane’s hydraulic system developed trouble and the landing gear failed to extend properly. The pilots



were not worried; they had full confidence in the built-in keels and informed the tower that they would make a wheels-up landing on the turf alongside the factory airport runway.

The high-wing configuration made possible a sort of “seaplane landing,” without propeller damage. Rudder control was available during the short landing run (slide?) of 615 ft and no skin buckling occurred on either the bottom or sides of the transport. The keels showed damage to fairing skins.

Although the soil was so soft it would not support the weight of an automobile, following heavy rainfall, resulting keel tracks show that the bottom of the aircraft itself did not touch the ground. For the most part the landing was accomplished in a straight line, after an initial touchdown swerve. The bottoms of the keels are shod with stainless steel and project three inches below the fuselage.

Lifting the *Twin-Quad* was simplicity itself. The wheels were lowered to the ground and the struts deflated. Shallow trenches were dug to permit the struts to move into a vertical position and the gear was locked down. An air bottle was used to inflate the struts, lifting the fuselage off the ground, and the plane was taxied out of the trenches under its own power.

Beechcrafters are to be forgiven if they wore smug expressions that day. They could truthfully say, “We planned it that way.”

The New Firestone SKY CHAMPION LEAKPROOF TUBE

**HOLDS AIR
4 TIMES
LONGER**

**Greater Safety • Added Economy • More Landings
Less Servicing • Fewer Tire Changes
More Retreadable Tires**

THE NEW Firestone Sky Champion Leakproof Tube brings you all these advantages at no increase in price or weight. The tube is made of natural rubber, chemically treated on the inside to greatly improve its air-holding qualities. This means greater protection to the tire because it operates through a greater part of its life at proper air pressure, providing greater safety on landings and takeoffs. This also means reduced maintenance cost due to less frequent inflating and fewer tire changes. Because the tire body is protected against the hazards of underinflation, it may be retreaded for additional service.

Write Firestone, Aircraft Products Division, Akron, Ohio, for more complete information on this outstanding new product.

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THIS**



**BUT
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**Firestone
SKY CHAMPION
TIRES and TUBES
Mean
GREATER SAFETY**

Landing a Helicopter, Engine-Off

DR. ALEXANDER KLEMIN
Helicopter Editor

AUTOROTATIVE landings have become commonplace, but pilots and engineers still differ on the best technique to follow. A fine analysis of the problem is that of an able young engineer, O. L. L. Fitzwilliams, of Westland Aircraft, in his paper before the Helicopter Association of Great Britain entitled "Some Work with Rotating Wing Aircraft."

We have learned many lessons from his paper, though it is based on a rather early model, the Sikorsky R-4B. Jimmy Viner and Ralph Lightfoot of Sikorsky, Floyd Carlson and Walter T. Bonney of Bell, have done their best to bring the subject up-to-date for us, and we thank them.

Pull-Out, Pull-Up and Flare

As a first lesson, what is the difference between pull-out-pull-up and flare?

To pull-out in England is to move the cyclic control stick back on a glide and flatten out to a level flight path. In American practice, apparently to pull-out is to apply power in order to come out from a glide.

To pull-up is to use the collective-pitch lever to check the vertical speed of descent, as a rule just before landing.

To flare is to pull back on the cyclic stick just before landing so that the rotor disk is at a large angle of incidence and develops a powerful braking drag. In American practice, one may also call it "flare" when pulling the stick back in the glide.

The three terms are closely allied, but they do not mean the same thing.

Chart of the Glide

In the curves of *fig. 1* Fitzwilliams gives us a useful lesson. The horizontal scale shows horizontal speed, the vertical scale shows rate of descent and both scales are equal. The dark arrow measures the resultant speed of the helicopter and the actual slope of the glide path. This graph applies to the Sikorsky R-4B, called the *Hoverfly I* by our British friends. The R-4B has a top speed of 85 to 90 *mph*. Its best glide is at about 70 or 72 *mph*. We note, therefore, that in an autorotating helicopter the best glide angle occurs much closer to top speed than in the airplane.

The second point to note is that the

minimum rate of descent is around 20 *fps* and is almost a constant between the point of best gliding angle, *B*, and the point of minimum steady-speed flight, *C*. Thus, in going from point *B* to point *C*, it is possible to make the glide several times as steep without increasing the vertical rate of descent—something that helicopter pilots either know or should observe carefully. Unfortunately, below the speed of point *C* the vertical rate of descent increases quickly, and at zero forward speed this rate is *twice* the minimum rate of vertical descent.

The Sikorsky R-4B can scarcely be called a modern aircraft, but the curve of *fig. 1* should be characteristic of later designs, and constitutes an addition to the theory of flight of the helicopter.

Killing Downward Velocity

We still have not reached the description of the actual landing process; we are building up principles:

"The most obvious thing," says Fitzwilliams, "about any method of performing an engine-off landing is that its primary purpose is to eliminate the downward velocity of the approach glide. Therefore, during some part of the landing maneuver, the vertical component of the total air force acting on the aircraft must exceed the weight for long enough to allow the downward velocity to vanish."

This statement is obvious, but it is a good introduction to another idea: to provide this extra total air force requires energy and in the glide there is no engine to provide the necessary power. The pilot must rely on energy

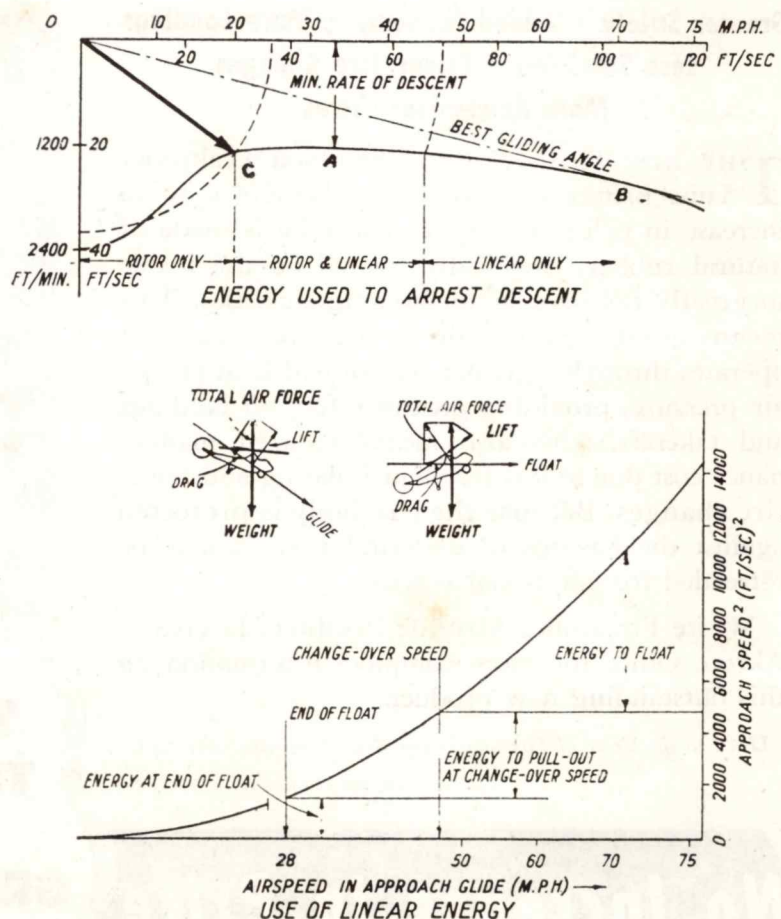


Figure 1

exchange, of which there are three classes or regions:

(1). *The Region of Linear Exchange.*—

This is a term novel to American ears, but an expressive one. In the R-4B, it is the region of the high-speed approach glide (about 65 mph for the *Hoverfly*). The glide is fast but not steep; the angle of incidence is small. The pilot pulls back on the stick, increases the angle of attack of the rotor and produces a small increase in thrust which is sufficient to reduce the vertical speed substantially, as shown in fig. 2. The rotor speeds up very little and the only exchange of energy lies in the loss of path speed—so that “Region of Linear Exchange” is the appropriate term.

(2). *Rotor and Linear Exchange.*—

Moreover, after the pull-out (British) or initial flare (American) to some 55 mph (as in fig. 2), there is still a good deal of kinetic energy left. The pilot can now, if he wishes, increase the incidence still further and “float” the helicopter on a horizontal path for 3 sec to 6 sec, for perhaps 100 ft. There is apparent defiance of gravity, but in reality there is a vertical speed of descent of the order of 2 to 5 fps. Now, however, as the aircraft loses forward speed, the rotor loses angular speed and gives up rotational energy, while the helicopter continues to lose linear energy. Hence this region of “Rotor and Linear Exchange.”

(3). *Rotor Exchange.*—Below 27 mph

or 28 mph, the lower half of fig. 1, shows it, there is little kinetic energy of forward flight left to convert. Now *all* the pilot can count mainly on is slowing down the rotor by increasing its blade angle with collective-pitch control. In this region the term “Rotor Exchange” is the right one.

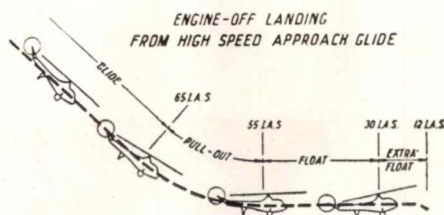


Figure 2

Changeover Speed

There is still another term that Fitzwilliams uses: the “Changeover speed,” at about 47 mph on the R-4B. He says that above changeover speed the pilot should *not* use collective pitch to kill vertical speed, and gives reasons:

“If he pulls back the azimuth stick at the same time he uses the pitch lever, he will find the helicopter doing an excessively hard pull-out, with the result that his last ground speed will be considerably greater than his first and he will have to down-pitch and quickly think of some other maneuver. . . . If the pitch lever is used first from a glide above the changeover speed, the velocity of the helicopter cannot be subsequently reduced to less than the minimum steady air-speed, so that the forward component of this velocity can be appreciably reduced only at the expense of a heavy landing.”

Putting it another way, if the pilot uses his collective pitch at the very beginning of the pull-out, he has nothing to fall back on later.

How Autogiro Pilots Did It

We have built up enough theoretical principles and can go on to actual landing. How did the “oldtime” autogiro pilots do it? Things move so rapidly in aeronautics that the autogiros appear hopelessly outdated; yet

there are many C30 autogiros still flying in England and, as far as engine-off landings are concerned, the autogiros (with low disk loadings and no tail rotor to worry them) had some advantage over the modern helicopter. Fig. 3 is reproduced from *The Autogiro and How to Fly It* (Pitman), a book written by our old friend, Reggie Brie.

The diagram is self-explanatory. The autogiro pilots had no collective pitch lever to help them, but with disk loadings of less than 1.5 psf and no tail rotor, they could come down either vertically or with stick back in a very steep glide with 10 mph ground speed. In either case they managed to keep control. At 150 ft above the ground they would push forward on the stick, pick up a speed 30 or 40 mph. Finally they would pull back and flare out, and the autogiro would land lightly and stop in a run of just a few feet mainly because of the enormous drag of the tilted-back rotor.

Are Steep Descents Practicable?

Mr. Fitzwilliams thinks they are not. “In engine-off landings from approach glides as steep as that indicated by the arrow (fig. 1) the elimination of downward velocity is dependent entirely on the use of the collective-pitch control, as a means of extracting energy from the rotor to provide vertical force, and none of the helicopters in common use today is suitable for landing gently at zero ground speed in still air from an approach glide of this kind.”

The statement sounds plausible, but do our skilled pilots agree with it?

Our impression is that skilled pilots are *not* afraid of making the steep descents with which Jim Ray, Reggie Brie and other autogiro pilots used to astound onlookers. It is true that modern helicopters have higher disk loadings, but, to compensate for this, they have more rotor speed and more rotational energy in the rotor. Our impression, contradicting Fitzwilliams with all due respect, is that our pilots can do it, when they want to make steep descents at low forward speeds, and know exactly at what point above the ground to increase the blade angle collectively and to cushion the landing shock.

Sikorsky Practice

Here is a highly pertinent quotation from the *International Handbook of Aeronautical Engineering* in which R. B. Lightfoot and D. D. Viner are collaborating:

“At the higher altitudes pitch should be decreased quickly to increase the rotor speed. The stick should be moved forward to drop the nose and acquire a
(Continued on page 70)

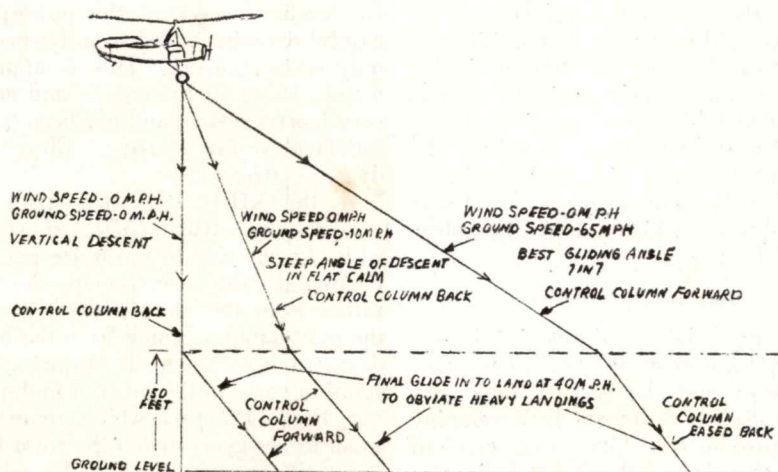


Figure 3

ATC for Hiller 360

AN AIRWORTHINESS certificate has been granted by CAA to the utility *Hiller 360*, built by United Helicopters, Inc., Palo Alto, Calif. United is the third company to receive a helicopter ATC, with "6 H 1" as the designation.

Equipped with a 178-hp engine, the utility 360 was designed to meet the immediate demand for specialized applications in industry, agriculture and commerce, and has been stripped down and designed to provide moderate cost, an indispensable element of successful helicopter operation. The *Hiller 360* is already in limited production and orders for all major parts and assemblies have been placed with various sub-contractors throughout the U.S.

A unique characteristic of the 360 lies in its simplified control system. Basically, this system consists of an overhead control stick, connecting through a simple linkage to a servo-control rotor. The overhead control stick eliminates all of the cables, pulleys, and levers found in conventional helicopters. In turn, the control rotor is a simple aerodynamic servo which controls the main rotor.

The pilot actually "flies" the control rather than the lifting blades. There is ease of control and elimination of stick shake. It is also claimed that the self-dampening action on the part of the control rotor corrects any oscillation of the helicopter and gives the air-



DATA

Gross Weight	2247 lb
Empty Weight	1447 lb
Useful Load	800 lb
Powerplant, Franklin Model 6V4-178-B33	
Rotor Diameter	35 ft
High Speed	84 mph
Cruising Speed (70% Power).....	75 mph
Range	200 miles
Endurance	2.5 hr
Vertical Rate of Climb	400 fpm
Maximum Rate of Climb	900 fpm
Service Ceiling	Over 10,000 ft
Maximum Vertical Takeoff Altitude (No Wind)	6000 ft

craft what amounts to a full stability.

The new helicopter has an excellent load to gross weight ratio and is of all-metal, semi-monocoque construction throughout.

The flexibility of the design is such that equipment for crop-dusting, air-mail, cargo, photography and survey operations can all be installed easily on the basic flying structure without affecting either performance or flight characteristics.

The *Hiller 360* has high significance for commercial helicopter operation.

Helicopter Society Activities

THE new officers of the American Helicopter Society, who constitute the Council, represent all the important regions of the helicopter industry. The Council includes:

President: R. B. Lightfoot

Vice-Presidents:

E. Katzenberger, B. Kelly,
—New England —New York
L. Leavitt, C. Wood,
—Pennsylvania —Mid West
H. Pentecost,
—West Coast

Secretary: T. R. Pierpoint

Treasurer: V. R. Short

Committee Chairmen:

F. Carlson, H. S. Tremper,
—Membership —Publication
V. R. Short, B. P. Labensky,
—Merit Award —Technical

Council Member at Large: Monroe Brown

There are welcome signs of activity. The New England section has heard I. B. Benson of General Electric describe the *Rotochute*; on Dec. 3 the Society held its annual honors dinner; the proceedings of the 1948 Philadelphia Forum are being printed; and at a Philadelphia local meeting, L. L. Douglas, chief engineer of Kellett Aircraft Corp. gave an interesting account of "Development Problems of Large Helicopters," which follows in abbreviated form.

The Kellett XH-10

An appreciable increase in size introduces a host of new and unexpected problems, and the XH-10 Helicopter which Kellett is presently developing is approximately three and one-half times the size of the XR-8 helicopter in gross weight and twice the size of the XR-8 in rotor diameter.

The XH-10 powerplant is exhaust-

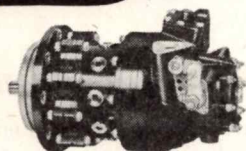
cooled and saves approximately 5% of the normal cooling power, which means a 10% increase in useful load. In another aspect of the powerplant careful experiment led to a flywheel of only 8 lb/inch/sec². This is approximately 167% of the engine and accessory inertia system and has been found satisfactory for starting, idling and dynamic stresses.

In the XH-10, the oleo struts are low-pressure struts (350 psi static) with O-ring seals to minimize packing friction. In the early rev-ups the tires rather than the oleos moved, so that the only damping came from the blade dampers, which was inadequate. The solution came in the form of high-pressure tires (125 psi) which, under the small forces generated at the rotor hub, were stiff enough to force oleo motion and thereby provide adequate damping for the helicopter.

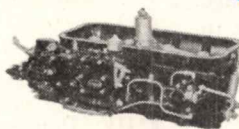
In small helicopters it is possible to

Bendix Products

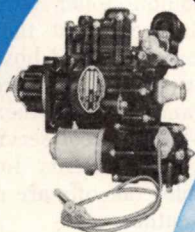
AIRCRAFT FUEL METERING SYSTEMS



Bendix*
Direct Fuel
Injection Pump.



Stromberg* Injection
Carburetor
for large engines.



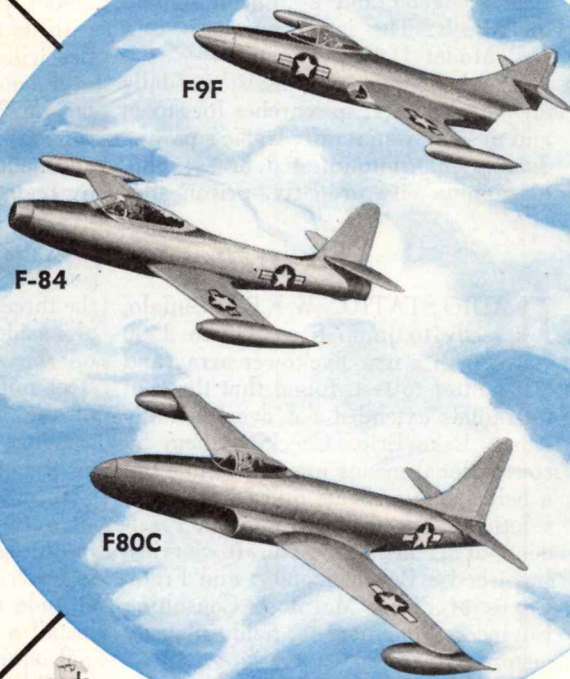
Bendix*
Speed-Density
Fuel Metering Unit.



Stromberg*
Float Type
Carburetor.



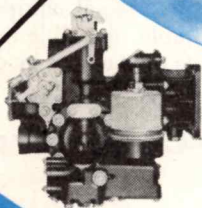
Stromberg* Injection
Carburetor for
personal planes.



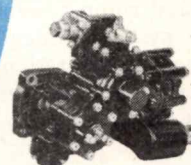
F9F

F-84

F80C



Bendix* Fuel
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In two years of flight use, Bendix Fuel Metering Controls have set a remarkable record for *efficient, versatile, and dependable* operation. Today they are continuing to set the pace on such planes as the F9F, the F84, and the F80C.

Efficient: New use of altitude compensation . . . practically isochronous in operation . . . constant air-fuel ratio and temperature for acceleration.

Versatile: Work equally well with gasoline or kerosene . . . With or without water injection . . . Adaptable to various exhaust nozzle areas . . . Can be modified to handle surge limitations.

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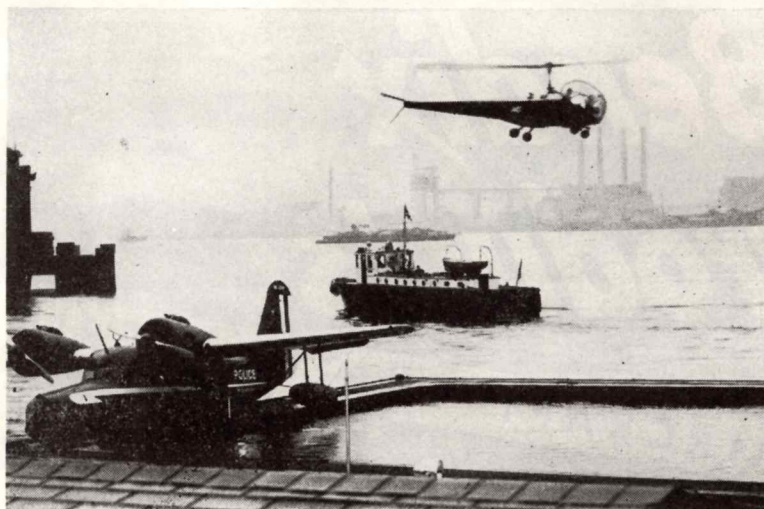
balance the outer 50% of the blades about the quarter-chord point and still maintain satisfactory flying qualities, but with the larger XH-10 the instability of the rotor blades and the sensitivity to even low-velocity gusts made flying tiring and difficult. By balancing the entire rotor blade forward of the quarter-chord point it was possible to hover the XH-10 helicopter hands-off for several seconds.

It has been believed that if rotor blades were balanced along the quarter-chord point blade flutter was not possible, since there were no coupling forces. Yet, in the early stages of flight testing, at about 30 *mph*, the XH-10 exhibited a divergent oscillation of the blades collectively with a similar fuselage mode 180° out of phase. Damping in the flight-control system cured this condition.

In large rotor systems the dynamic effects, which may be neglected in small rotors, represent a large item in the life of the control system.

Past experience indicates that the chordwise oscillation of the rotor blade varies from 1½ to 2° in level-flight high speed up to 3 to 4° in large acceleration pull-up. The loads on the damper, and hence the chordwise bending moments, during these oscillations are a function of the oil temperature in the case of the viscous-type damper. It has been found that most dampers have peculiarities in various operational regimes and require thorough investigation to make their action in service predictable.

A combination of powerplant, transmission, and rotor presents a complex dynamic system which has many natural modes of vibration and requires careful consideration. In the XH-10 helicopter, an extensive survey was made in flight involving the stresses throughout the transmission system in all modes of flight in both single- and twin-engine operation. It was found that the maximum dynamic stresses are approximately 15% of static stresses and that these occurred during specific narrow-operational regimes.



Courtesy N. Y. City Police Dept.

Police Buy a Helicopter

THE Police Department of New York City has used airplanes for more than 20 years. Its Aviation Bureau has a Grumman *Goose*, a Grumman *Widgeon* and a Stinson *Reliant* on wheels. The latest purchase is a Bell Model D-47 helicopter.

The helicopter will assist in daily air-patrol flights; in searches for stolen and missing watercraft; traffic surveys; dusting mosquito-infested areas; photographing city property, prison sites

and fire zones; return of fugitives on extradition proceedings; enforcing regulations and investigating accidents.

Police Commissioner Arthur W. Walander points out that the helicopter with its slow speed and hovering abilities will be invaluable in rescue work over land and sea. Further, it can be put on 24-hour patrol service, since a runway is not necessary for a takeoff and helicopter takeoffs are not affected by poor weather.

Helicopter and Radio

RADIO STATION W E R B, Buffalo, ready to jump from 250 to 2500 watts, with a new five-tower array and transmitter to test, found that three of its radials extended out over partially frozen Lake Erie. Checking them by conventional means was impossible but a helicopter on floats offered the ideal solution. Edward S. Robinson, President of Helicopter Aircraft Service, furnished a Bell helicopter, and Frank Englis of Frank McIntosh Consulting Engineers, mounted a field intensity meter in the ship.

Within two hours Englis was able to take and record 65 measurements on

the three radials. Landings were made alongside the new transmitter building, on the slag dumps near the Buffalo steel mills and on the frozen surface of the lake. However, most of the readings were taken with the Model 47 flying about 50 *ft* above the lake.

In other tests it has been found possible to secure a vertical pattern of radio signals by taking measurements in hovering flight every 200 *ft* up to an altitude of 7000 *ft*. Robinson plans to install a radio compass and other special equipment and believes it will be possible to run complete field measurements in one day's time.

Wrights' "Kitty Hawk" Home at Last—Collier Trophy Award

CEREMONIES on Dec. 17, 1948, 45 years after the world's first flight in a piloted, powered airplane, marked the return of the original Wright plane from the Science Museum in London, where it had been sent by Orville Wright in 1928 after Smithsonian Institution officials refused to concede that the box-kite *Kitty Hawk* was the first airplane to fly. Assured that the Smithsonian attitude had changed, Orville, some time prior to his death on Jan. 30, 1948, directed that the plane be returned to the U.S.

The Wright flier now occupies the spot of highest honor among the Smithsonian's exhibits. The plane was presented to the U.S. by representatives of the estate. Chief Justice Fred M. Vinson, chancellor of the museum, accepted title and Vice-President-elect Alben W. Barkley delivered the address.

During the day President Truman awarded the 37-year-old Collier Trophy for 1947 for the achievement of supersonic flight. Co-recipients are John Stack of the NACA, for research in high-speed flight since 1929;

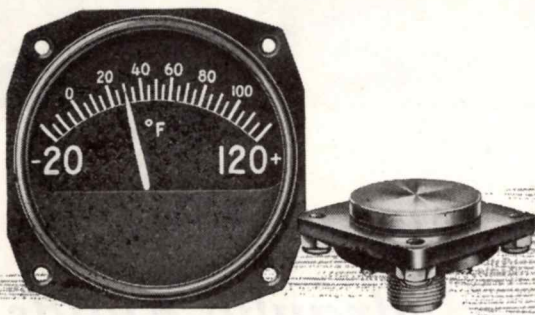
Lawrence D. Bell for design and construction of the X-1 research plane; and Air Force Captain Charles E. Yeager, the first pilot to fly it at supersonic speeds (Oct. 14, 1947).

At an evening dinner the NAA awarded the newly established Wright Brothers Memorial Trophy to Dr. William T. Durand for his many enduring contributions to aviation. At Kill Devil Hill, N.C., scene of the first flight, jet planes streaked overhead and helicopters and blimps formed a "wreath" above the memorial shaft during ground ceremonies.

For the wings of tomorrow

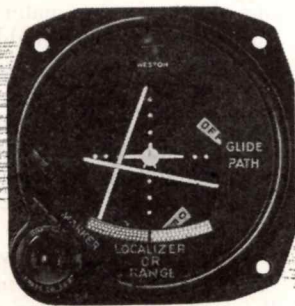
WESTON Tail Pipe Thermometer

—used on the new jet power plants



WESTON Free Air Thermometer

—featuring Weston's flush mounting resistor bulb



WESTON Cross Pointer Indicator (1D-48)

—used with instrument landing systems

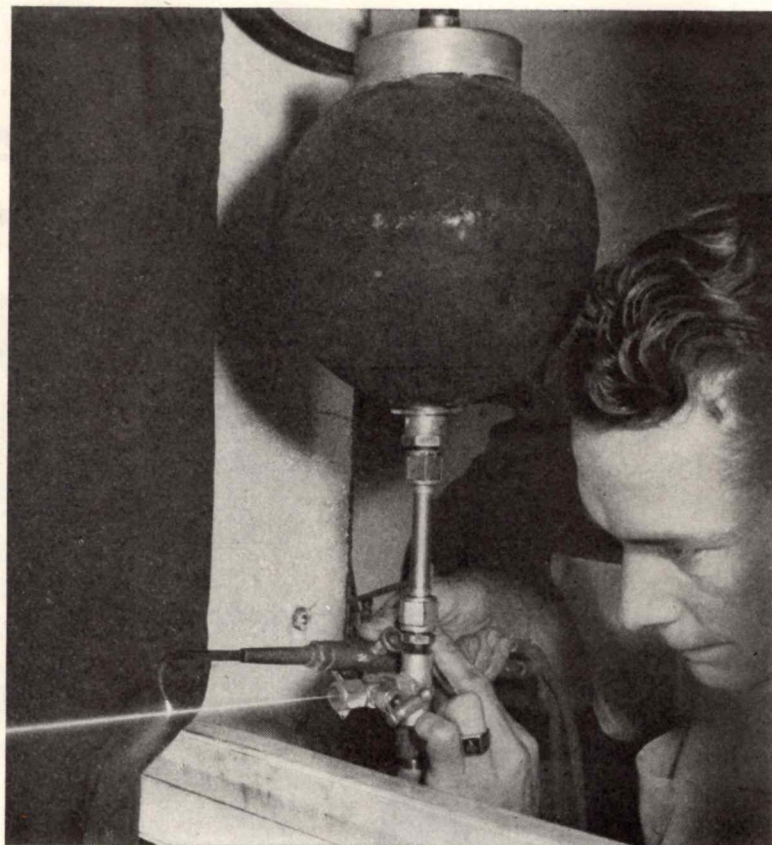
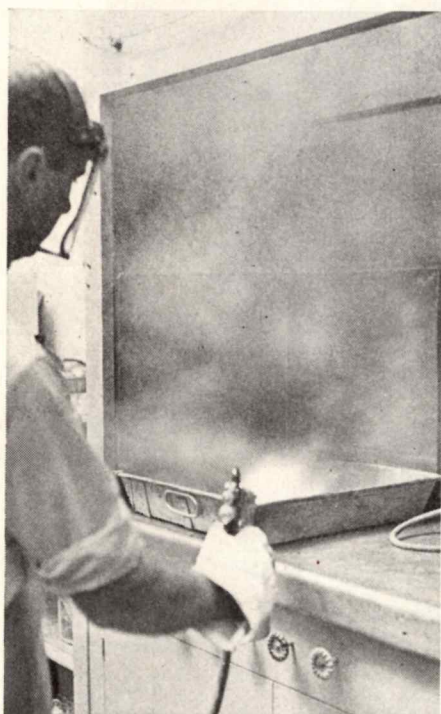
As new instrument needs arise in your planning, review the instruments now available at WESTON—where development has kept abreast of the latest requirements. Or, for special needs, complete engineering cooperation is freely offered. WESTON Electrical Instrument Corporation, 600 Frelinghuysen Avenue, Newark 5, New Jersey.

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New Orleans • New York • Philadelphia • Phoenix • Pittsburgh • Rochester • San Francisco • Seattle • St. Louis • Syracuse • Tulsa • In Canada, Northern Electric Co., Ltd., Powerlite Devices, Ltd.

Right: "Skydrol" stream out of a small orifice under high pressure does not ignite when contacted with oxy-acetylene torch. Below: "RPM Fluid" sprayed from an atomizing gun, actually extinguishes flame supported in a pan by an inflammable fluid



Non-Flammable Hydraulic Fluids

IT IS an undisputed fact that, when the need for development of a certain type of product becomes insistent enough, someone invariably comes along with the right answer. This is well illustrated in the case of safety hydraulic fluids for aircraft.

Actually, two new hydraulic fluids were announced almost simultaneously on the West Coast. A joint announcement by Douglas Aircraft Co. and Monsanto Chemical Co. introduced *Skydrol*, a synthetic liquid so fire-resistant that it is practically non-flammable. The second announcement came from Standard Oil Co. of California introducing *RPM Fluid*, claimed to be completely non-flammable.

Skydrol is an oily fluid designed to lubricate and forestall corrosion as well as remain fairly stable under temperature extremes. In addition to serving the requirements of the regular hydraulic system of an aircraft, it will operate cabin superchargers and expansion turbines for air-conditioning systems.

Under the High-Temperature Ignition Test—spraying the fluid out of a small orifice at 1000 *psi* and trying to ignite the thin stream with an oxy-acetylene torch—*Skydrol* can hardly be made to flash and is self-extinguishing the moment the torch is removed. When dropped upon a glowing red-hot manifold pipe, the fluid does not burn and drips off or vaporizes to some degree. When sprayed from a paint gun upon a burning rag, the fluid does not feed the fire or increase its intensity.

Operational Test

Skydrol was operated in a hydraulic-system test stand for the equivalent of more than 4000 flight hours and is claimed to have shown less viscosity loss than conventional fluids operated for only half that time. The pump used in the test was still in serviceable condition and was later returned to test-stand use.

It is claimed to have operated under hydraulic pressures up to 5000 *psi* with a negligible loss of film strength

and to be virtually inert, chemically.

California Standard claims *RPM Fluid* to be completely non-flammable and has placed it upon the market. Its basic raw material is derived from a highly flammable petroleum gas, later converted into a non-flammable fluid.

RPM too was put through the spectacular heat-and-flame tests and compared with hydraulic-fluid types in use. It refused to ignite. In one singularly tough test, a piece of aircraft insulation was soaked with the fluid and hung up, being allowed to dry for several days. It was still non-flammable upon test. Some other "non-flammable" fluids are said to lose their fire-resistant qualities under this trying test.

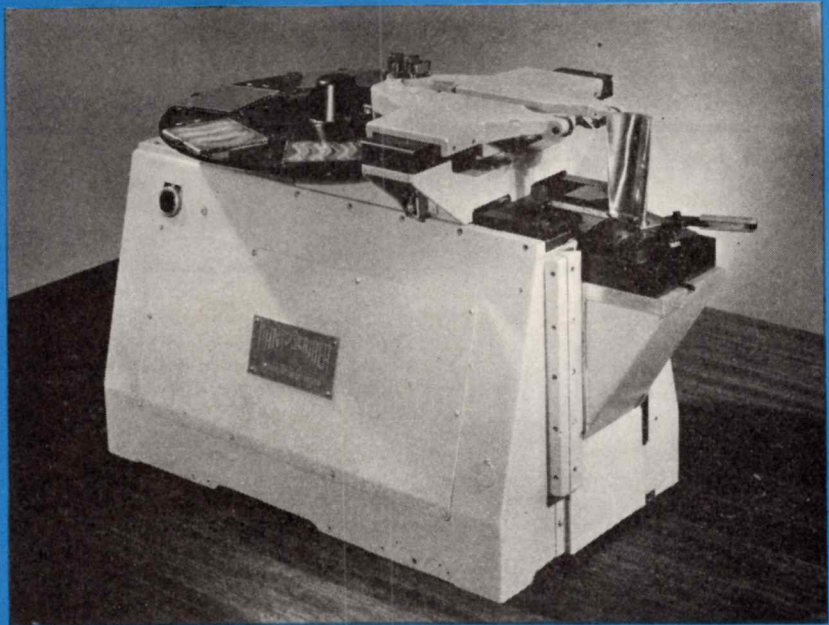
Operational tests are said to have shown Standard's fluid equal to or superior in lubricity and viscosity characteristics to any of the regular fluids.

Both *RPM* and *Skydrol* required more than two years of intensive ex-

(Continued on page 92)

INSPECT TURBINE BLADES

3
SECTIONS
IN LESS THAN
1
MINUTE



THE PANT-O-SCRIBER*

Model 300 Pant-O-Scriber Blade Checker is used for checking 3 sections of finished turbine blades. Indexing table for holding the Pant-O-Scribing Glass automatically rotates a known distance as blade is automatically indexed for checking sections E-E, C-C, A-A.

PRODUCTION TESTED the Pant-O-Scriber is a proven answer to the need for faster and better inspection methods for checking contour profiles, thickness, width, displacement or twist relationship and the leading and trailing edges of turbine buckets, blades, nozzle vanes, master patterns and discs.

It's FAST and AUTOMATIC in operation . . . scribes a PERMANENT INSPECTION RECORD on glass. This, when projected simultaneously with the master chart at any magnification onto a white screen, permits the inspector to see the ENTIRE CONTOUR PROFILE of each blade-section being checked.

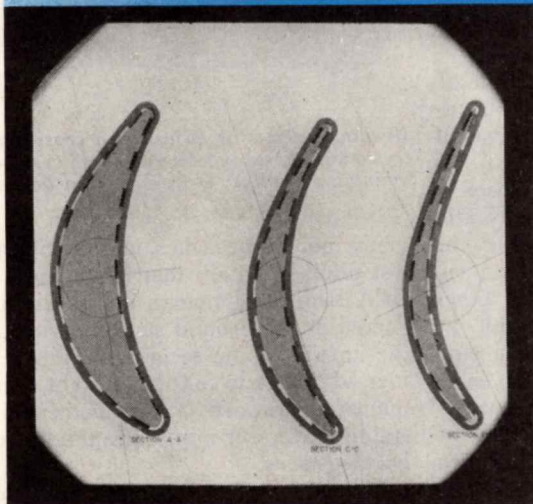
The Pant-O-Scriber provides a UNIFORM METHOD OF INSPECTION for engineering departments, production lines and vendors. It is available in sizes for checking the smallest of turbine blades to the largest of propeller blades. It's COMPACT IN SIZE, can be placed on table for convenience of standing or sitting operator.

Full details will be sent on request.

*Patents Pending

Engineers Specialties Division

UNIVERSAL ENGRAVING & COLORPLATE CO., INC.
980 ELLICOTT STREET, BUFFALO 8, N. Y.



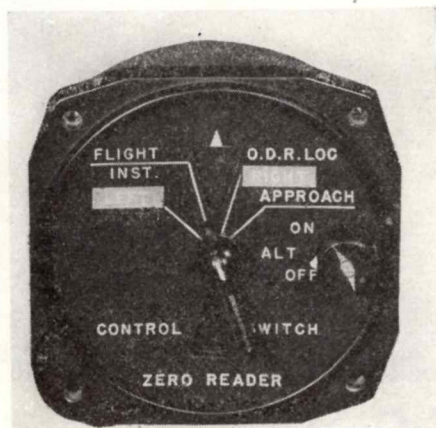
THIS is what the inspector sees in color on the screen where the green Pant-O-Scribed Contour (shown above in light gray) is projected together with a Red Bridge Tolerance Master Chart* (dark gray on photo.) Permissible tolerance is the depth of the "bridges." If blade is acceptable, light will show in all of these windows and nowhere else. The cross lines denote center of gravity of each section of the blade and twist angles. The circles are used for aligning the Master Chart and the Pant-O-Scribed blade sections.

OTHER MODELS

Model 325, also automatic, checks two sections of a finished or unfinished blade simultaneously. This model is valuable for checking unfinished cast or forged blades, before machining operations, to determine if they are within acceptable contour, thickness and twist tolerances.

Model 350 is hand controlled, motor driven, and especially designed for engineering and research development purposes, master pattern makers, vendor and tool room use. Also permits making measurements and permanent records of blades.

Manual Control Stability

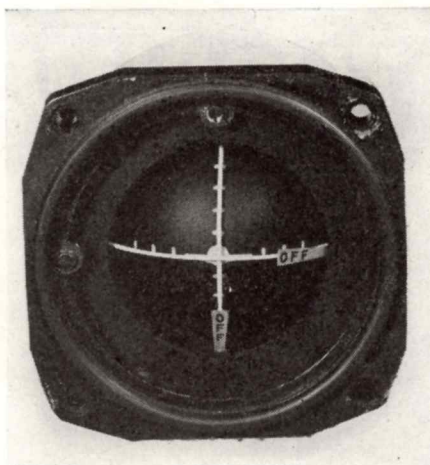


Switch to cut in radio track, glide-path signal, or altitude control. There are right and left radio-track positions

IN THE final analysis, man is floored by the little things. He may work long and hard, overcoming one major obstacle after another, only to be brought to the breaking point by the proverbial last straw.

Thus, aviators have been subject to the whims of the weather ever since the genesis of the flying machine. Weather conditions encountered in flight hold few terrors now—except for severe turbulence and heavy icing. The takeoff and cruising flight to destination have become matters of little moment, even though visibility is of a low order, thanks to the radio ranges and associated devices.

Not until the pilot approaches his target airport and is well down the ILS glide path heading squarely onto the allocated runway does he begin to accumulate the slight variations in instrument interpretation and control responses which plague every "instrument" landing. Why should this be so? Certainly he is provided with all the instruments necessary to tell him attitude, altitude, rate of descent, forward speed, etc., in addition to the cross-pointer markers now used to keep the plane on the glide path headed toward the airport localizer marker used



Sperry "Zero Reader." Zeroed cross lines mean plane is on selected course or coming to it at proper rate of approach

IRA F. ANGSTADT

Technical Editor

in the Instrument Landing System.

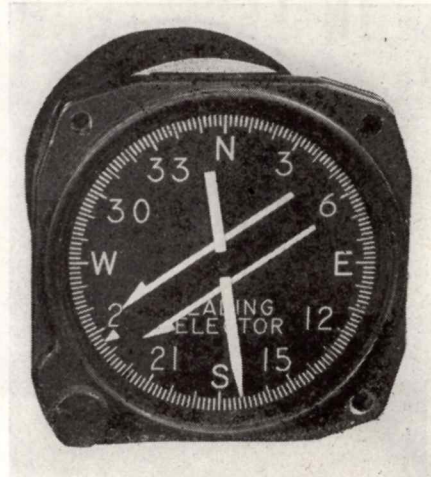
The Flight Research Department of the Sperry Gyroscope Co. calls it instability. And stability is not dependent upon pilot proficiency. The last few seconds of an instrument approach—even if the plane has practically slid down the glide path, straddling the localizer track all the while—can encounter sudden air currents or other disturbing forces which can not be corrected for in time to make a sure landing and a missed approach is rung up. If it is an airliner at a busy terminal, the pilot must proceed to the top of the "stack" and await his turn for another try—sometimes head away to an alternate airport.

When Conditions "Gang Up"

The situation is brought about by an accumulative set of conditions, each innocent enough by itself. The cross-pointer will indicate deviations immediately. However, the pilot must note them visually and move the aircraft's controls to counteract opposing forces—often over-controlling, "bracketing" the track excessively and setting up oscillations from which he may not be able to recover in time for a stable landing.

Much of it is a matter of time lag, from instrument-indicating to pilot-seeing-and-doing to aircraft-response. It is said that pilots frequently have to go around again in instrument approaches during smooth air conditions; variable cross winds or turbulence spoil

Through the "Zero Reader"



Heading selector is adjusted to cross-country course; keeping "Zero Reader" centered maintains heading. Drift angle can be read

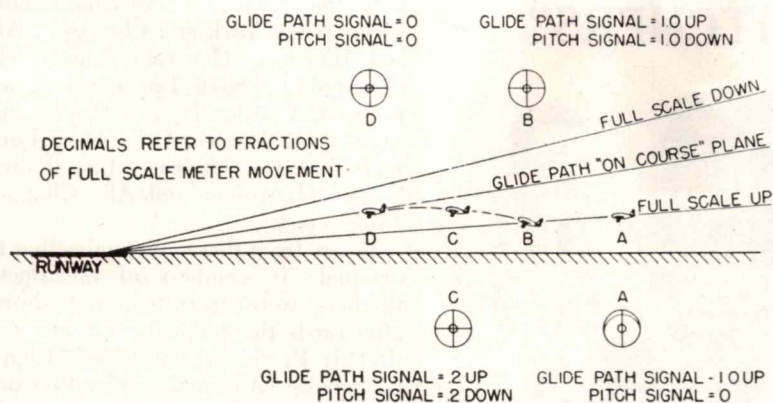
many more approaches, and the Sperry test pilots maintain that in the case of GCA additional human delays are incurred at the ground station. Here is the answer to the seemingly high ceilings of 200 ft to 500 ft as flight minimums at airports. Last-moment instability at lower minimums might well be disastrous.

What to do? Automatic-approach equipment has supplied the best answer so far. Electronic sensing of minute departures from the ILS flight path is instantly converted into slight, corrective control surface movements and instability is forestalled to within two or three seconds of contact—far below the airport minimums in force today.

Automatic-approach equipment is expensive; it is heavy and it requires top-flight maintenance. These ingredients add up to a stew which many operators cannot digest along with a myriad of mandatory installations.

Sperry engineers claim they have eliminated that last straw of the manual instrument landing. And a little personal experience flying their remarkable "seeing eye" has just about convinced this correspondent that they have the answer.

Their Zero Reader is exactly what its



Plane approaching ILS glide path receives a full-scale "up" signal at (A). Meter centers when craft is on proper rate of approach through (B), (C) and (D)

name implies: Keep the cross lines zeroed and the plane will be exactly on course. That doesn't sound helpful or hardly original; the same holds true for the standard ILS cross-pointer meter. Our first impression is to debunk a little—"Another instrument to keep watching." We quickly acquire a healthy respect for this mighty midget. Its performance makes fast friends of the most skeptical and experienced airmen. The amateurs are simply overwhelmed.

How It Started

Research during the hunt for an automatic-approach accessory for the Sperry Gyropilot sparked the development of the *Zero Reader*. The automatic pilot was incapable of integrating the calculations necessary to select and apply proper aircraft headings at correct time intervals from the information presented by the ILS cross-pointer meter. Just about then came the realization that perhaps an instrument could be developed to do that kind of thinking for the pilot during manual ILS approaches.

First, gyrosyn-compass signals and localizer-pointer indications were combined to obtain a signal which permitted the pilot to hold the localizer pointer on zero at all times during ILS approaches. Thus, the name *Zero Reader* was born.

Experimental flight approaches gave similar treatment to the glide path. Further flight testing and study added another improvement; the use of a bank signal to complement the compass information in combination with the localizer pointer.

The *Zero Reader* is a simple, two-element indicator with a horizontal and vertical line which are perpendicular at all times, instead of swinging from a pivot like the ILS cross-pointer lines. All the pilot does is "zero" the two pointers. He flies the aircraft by "following" the pointers. When the ver-

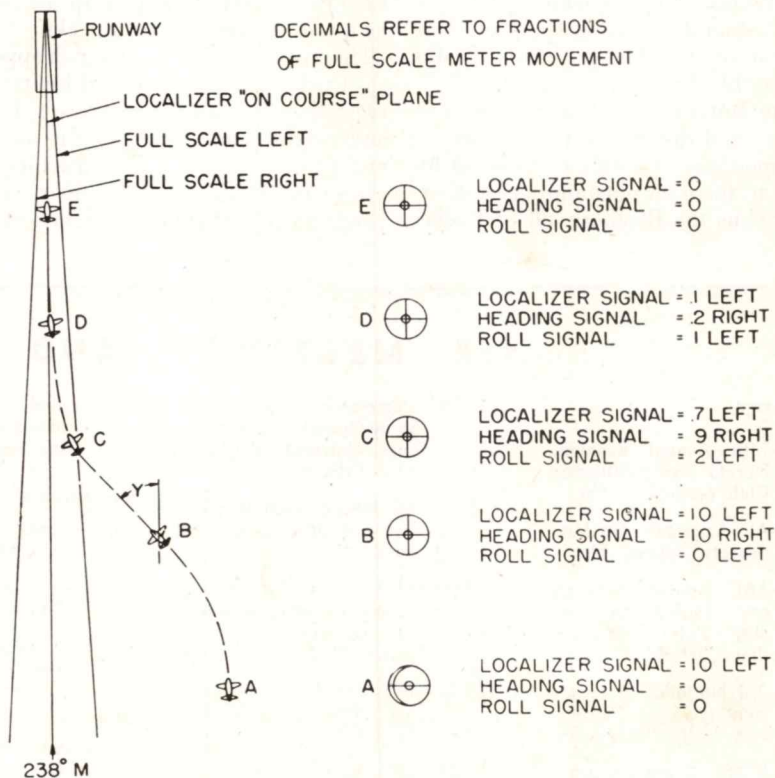
tical pointer moves toward the right he swings the control wheel to the right until the pointer is brought back to zero again. When the horizontal pointer moves up he pulls back on the control column to nose the plane up.

The *Zero Reader* does all the interpreting of signals received from the localizer and glide-path transmitters; it anticipates the approach of the aircraft to the true flight course and indicates a corresponding lessening degree of control; and close bracketing of the ILS beam is possible right down to the runway, although the localizer beam is increasingly sensitive toward the transmitter.

For instance, when the aircraft is to the right of the localizer course a "fly left" signal will be indicated by the vertical pointer moving left and the pilot turns the wheel left to bring the pointer to zero. As long as the aircraft is kept to the proper rate of approach to the true course—even though the plane is not yet aligned with the localizer track—the vertical line will remain zeroed. If under-control or over-control is applied by the pilot, the indicator will immediately show it, in the direction in which a correction has to be made.

The Arc Approach

The approach to the localizer course is made asymptotically. (As the aircraft approaches the true course, the corrective angle is progressively lessened so that the flight line becomes a comfortable arc instead of a straight approach to the course, followed by an abrupt heading change to remain on course.) As the aircraft comes nearer the proper heading, the localizer signal is reduced and less compass signal is required to neutralize the vertical *Zero Reader* pointer. If the aircraft is flown with the pointer continually on zero, the localizer course will be reached and maintained smoothly, without the usual wide "bracketing" until the heading is stabilized. The airplane sort of "glides" up to the true course and falls easily in step with it. (Continued on page 87)

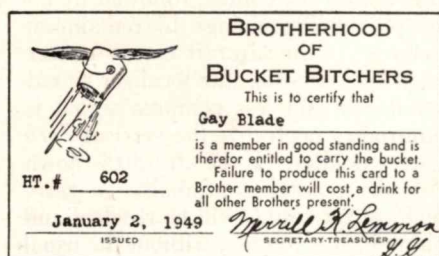


Parallel with localizer track at (A), pilot receives "fly left" signal. Approach angle decreases through (B), (C) and (D) until plane is exactly on beam (E)

"THE BUCKET BITCHERS"

HERE'S a new slant on the famous "Short Snorter" fellowship — the Brotherhood of Bucket Bitchers. Failure to produce membership card when challenged by a brother member will cost a drink for all Brothers present. And who are the Bucket Bitchers?

Late one dreary afternoon in the winter of 1944-45, when the U. S. aircraft gas turbine industry was in its infancy, Charley Brooks of Austenal Laboratories (New York) and Merrill Lemmon of General Electric (Syracuse) were riding on the Empire State Express from Buffalo to Detroit. They conceived the idea of banding all those unfortunate souls who deal with tur-



bine buckets together into one great Brotherhood of common agony.

They thought that these men who now wince at such terms as "contours," "serrations," "leading edge," and "porosity" should band together for their common support and a sharing of the common burden.

"The Burden" has made these men separate and distinct from all others—these men are of a caliber to band together to form an outstanding Brotherhood. Thus the Brotherhood of Bucket



Shown above is a necktie clasp with scaled-down I-40 (now J33) turbine bucket, and at left sample membership card

Bitchers was born!

It was proposed that, for an initiation fee of \$2, each member would be furnished with (1) a certificate of membership, (2) a membership card and (3) a one-tenth scale size I-40 turbine bucket arranged to be worn as a watch charm or on a necktie clasp. (The initiation fee was later dropped).

"Curly" Lemmon sent out invitations to engineers engaged in bucket design and production at such outfits as General Electric's Aircraft Gas Turbine Engineering Division and Supercharger Engineering Division (Schenectady,

Lynn and Syracuse); Austenal Laboratories (New York and Chicago); Allison Division, General Motors (Indianapolis); Steel Improvement and Forge Co. (Cleveland); Haynes-Stellite Co. (Kokomo); Utica Drop Forge and Tool Co. (Utica); City Pattern Works (Detroit); and Allis-Chalmers (Milwaukee).

It was from these companies that the original 70 members of the Bucket Bitchers were recruited, and shortly afterwards the following officers were elected: President (Pale Chief), Charles P. Brooks (Austenal); Vice-President (Spare Pail), Chauncy Waterbury (Allison); Treasurer (Empty Bucket), T. K. Houston (G.E., Schenectady); Secretary (Ink Pail), Merrill K. Lemmon (G.E., Syracuse).

Suggestions for bylaws flowed in freely from the various "Bucket Brigades," and some features are noted below. Bucket Brigades were formed in other companies, notably Westinghouse, Thompson Products, Packard, Flader, Pratt & Whitney, Boeing, Kellogg, Ranger, Solar, Elliott, Wright Aeronautical, and in England, at de Havilland and Napier. There are now about 400 active members, including many who have since transferred to an entirely different type of work.

Among other things, the by-laws provide that local chapters called "Bucket Brigades" may be formed. . . . Local chapters may vote with three members present, a fourth being necessary in case of a tie, and a "fifth" being required in order to stagger through a design change. . . . Turbine blade design engineers will be known as "Bucket Butchers." . . . A member must never be Zygloed or X-Rayed, because he is bound to be shown up as cracked. . . . Membership will terminate upon kicking the bucket.

AIR MEETINGS AND EVENTS

January

- 5—14th Annual Reunion, Florida Flying Alligator Club, Melbourne, Fla.
- 7-9—All American Air Maneuvers, Miami, Fla.
- 10-14—SAE Annual Meeting and Engineering Display, Hotel Book-Cadillac, Detroit.
- 10-14—3rd National Materials Handling Show, Convention Hall, Philadelphia
- 11—ICAO Communications Division, Montreal

- 12-14—Commercial Aircraft Spray Operators Conference, University of Illinois, Urbana
- 13-14—4th NAS Council Meeting, AIA Offices, Hollywood
- 18 (to Feb. 11)—Air Transportation Institute, American University, Washington, D. C.
- 24-27—IAS 17th Annual Meeting, Hotel Astor, New York City
- 27—SAE Metropolitan Section, Fuels and Lubri-

cants Meeting, Engineering Societies Building, New York City

February

- 8—ICAO Operations Division, Montreal
- 15—Inter-American Travel Congress, Buenos Aires
- 22—ICAO Airworthiness Division, Montreal

March

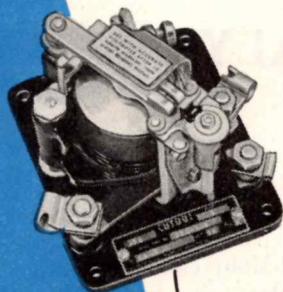
- 3—SAE Metropolitan Section, Air Transport Meeting, Engineering

Societies Building, New York City

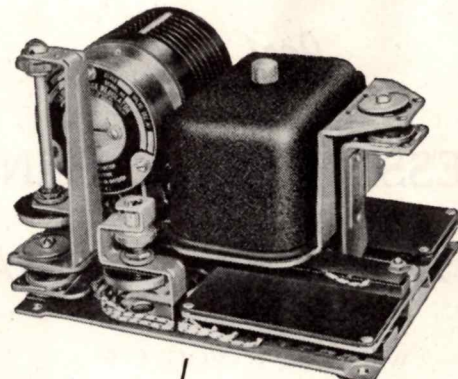
- 24—SAE Metropolitan Section, Aeronautics Meeting, Engineering Societies Building, New York City

April

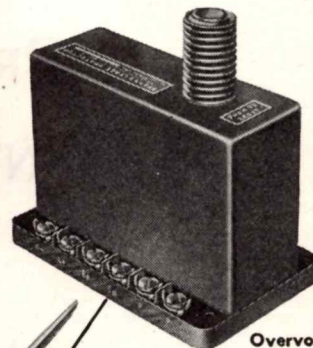
- 3-6—American Assn. of Airport Executives Annual Meeting, Oklahoma City
- 11-13—SAE National Aeronautic and Air Transport Meeting, Hotel New Yorker, New York City



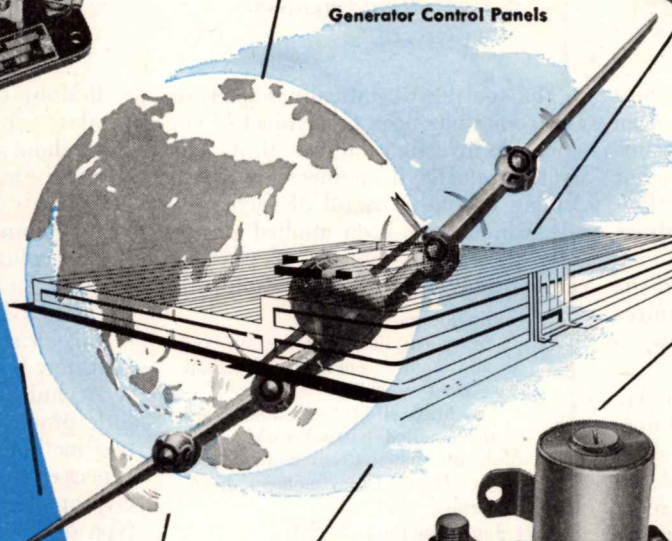
Reverse Current Cutouts
(Maximum Capacity, 100 Amperes)



Generator Control Panels



Overvoltage Protectors

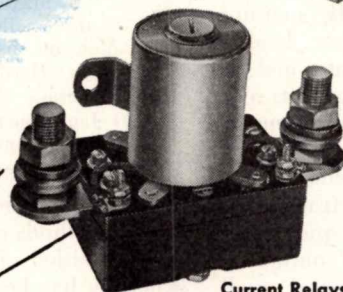


Automatic Pilots
Flight Path Control Systems
Engine Instruments
Flight Instruments
Navigation Instruments

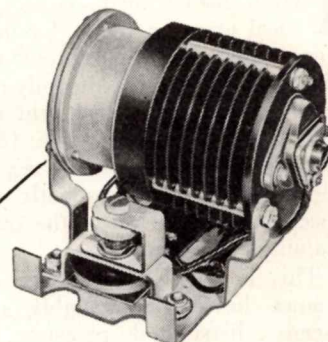


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PRESSURIZED-CABIN ELEMENTARY FRAME ANALYSIS

WILLIAM F. VOGEL
Consulting Engineer

IF ALL pressurized aircraft cabins conformed with the concepts of an ideal pressure vessel, having a circular cross-section, no cutouts or other discontinuities, and uniformly distributed pressure, their structural analyses would be relatively simple (Ref. 1). But such is not the usual case, and the resulting problem frequently requires special consideration of the transverse framing structure.

This is true not only for circular frames having appreciably non-uniformly distributed pressure loading (due to aerodynamic pressure and the like), but also on a more severe scale in all pressure-loading conditions of non-circular frames, regardless of cutouts or other structural discontinuities. As many of the transverse frames in a conventional, semi-monocoque, metal fuselage are usually either continuous, moment-carrying rings or some modification thereof, the structural engineer must be prepared to utilize extensively certain statically indeterminate methods of analysis to effect a safe and efficient design.

The analysis of statically indeterminate frames has been the subject of considerable investigation in both its aeronautical and civil engineering aspects. Among the more useful of such methods, which have been applied successfully to various phases of pressure-cabin frame design, are the following:

- (1) Strain-energy methods:
 - (a) Castigliano's deflection and minimum energy theorems ("least work")
 - (b) Maxwell-Mohr method sometimes called "virtual work"
- (2) Moment distribution method:
 - (a) Hardy Cross moment distribution (Ref. 2)
 - (b) James' method (Ref. 3)
- (3) Certain approximate analytical estimates for preliminary design.

Of the foregoing, perhaps the strain-energy methods deserve first consideration, for either of these, 1 (a) or 1 (b), generally has been proved satisfactory for general non-circular applications, as well as being useful in certain highly complex problems beyond the scope of this article.

The "minimum energy" and Max-

well-Mohr concepts are fundamentally similar, being mathematically identical throughout a considerable portion of the analysis. The fundamentals of both are given detailed treatment in a number of standard works on mechanics and structural theory (Ref. 4, for instance), so we shall assume here that the reader has already availed himself of this elemental information.

It may be added that, from the purely technical standpoint, there is so little practical difference between these two methods that the engineer should expect equal results from both, if properly applied. Choice of either for this type of frame analysis lies more with personal preference than with theoretical superiority. Castigliano's method, however, is perhaps a bit easier to use in more complex cases, where some difficulty possibly might be encountered in setting up the same problem on the Maxwell-Mohr basis.

Referring to fig. 1, let us examine the analysis of a simple pressurized frame by the minimum strain-energy method. Taking p = uniformly distributed internal pressure and l = frame spacing (frames assumed parallel), a uniform outward pressure load of pl #/in is applied to the frame at the skin line and acts normal to the skin at all points. We may refer to this type of analysis as one involving "barrel stave" loading because the skin hoop tension is neglected and all pressure is assumed to be reacted directly by the transverse frames.

The term "barrel stave," as applied to this load distribution, implies a condition analogous to that in which the staves of a barrel act as beams to load the barrel hoops (frames). The validity and theoretical limitations of this assumption for pressurized-cabin design will be discussed in Part 2.

The engineer familiar with the usual types of ring-bulkhead problems encountered in non-pressurized fuselage design will immediately recognize this pressurized-frame analysis as merely a special loading of a statically indeterminate ring.

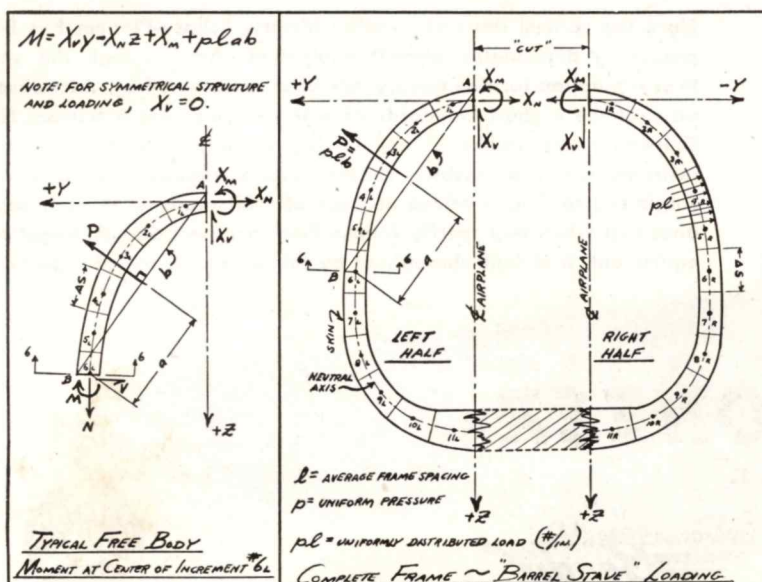


Fig. 1.—Typical frame with uniformly distributed pressure load—hoop tension in skin neglected

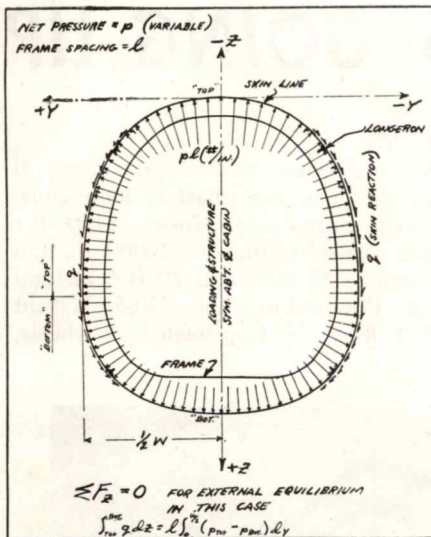


Fig. 2.—External equilibrium of symmetrical frame with symmetrical, non-uniform pressure

The crown or top of the frame of fig. 1 is "cut" for analysis purposes at the fuselage centerline or plane of symmetry. Redundant shear, axial load, and bending moment (X_v , X_n and X_m respectively) are applied to each side of the "cut" in the plane of the frame as shown. These redundants must be obtained from requirements of geometric continuity and will have simultaneous values just sufficient to close the "cut" with regard to the relative angular and translational displacements of the opposite cut faces.

If we choose to think in terms of deflection, it can be shown (Ref. 4) that the simultaneous conditions for zero relative deflections of the opposite faces of the "cut" are:

$$\frac{\delta W}{\delta X_v} = 0 \quad (1)$$

$$\frac{\delta W}{\delta X_n} = 0 \quad (2)$$

$$\frac{\delta W}{\delta X_m} = 0 \quad (3)$$

where W = total internal strain-energy stored in the frame structure.

If the "cut" is made at the cabin centerline and if both structure and loading are symmetrical about this centerline (a common condition in pressurized fuselages), it may be shown that $X_v = 0$. This eliminates all necessity of considering the shear redundant in such cases and reduces the simultaneous elastic equations to two:

$$\frac{\delta W}{\delta X_n} = 0 \quad (2a)$$

$$\frac{\delta W}{\delta X_m} = 0 \quad (3a)$$

The evaluation of these strain-energy derivatives constitutes a large portion of the analysis and thus should be

simplified as much as possible. Under ordinary conditions, the majority of conventional pressurized frames will have dimensions such that flexural strain-energy affects deflections to a much greater extent than do the contributions of shear and axial work. Thus, in the simple case of fig. 1 we shall consider only flexural work.

The engineer should bear in mind, however, that occasional frame problems will arise in which shear- and axial-strain energy may contribute a very important increment to the total deflections, and such analyses must be modified accordingly. This is particularly true of frames or bulkheads, having deep shear webs or high axial loads not traceable directly to cabin pressure.

Making the usual assumption of a straight-line stress distribution across any section of the frame (although such an assumption may be considerably in error for stresses exceeding the proportional limit or where local severe curvature of the neutral axis exists under elastic conditions), the internal strain-energy of flexure may be expressed as:

$$W = \frac{1}{2E} \int_F \frac{M^2}{I} ds \quad (4)$$

where M = bending moment in the frame at any point on centroidal axis

E = Young's modulus (assumed constant throughout entire frame)

I = moment of inertia of corresponding frame section, including flexurally effective skin at outer flange (say, $A_{EFF} = 30 t_{skin}^3$)

s = curvilinear distance along frame neutral axis, measured from an arbitrary origin (In our case, this

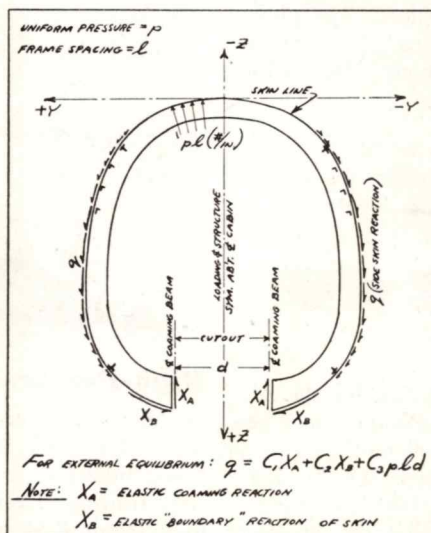


Fig. 3.—External equilibrium of a symmetrical frame with cut; showing "typical" free body

origin lies at the "cut" in the crown of the frame.) indicates integration completely around the frame.

The strain-energy derivative in this case then is:

$$\frac{\delta W}{\delta X_x} = \frac{1}{E} \int_F \frac{M}{I} \left(\frac{\delta M}{\delta X_x} \right) ds \quad (5)$$

where X_x represents the particular independent variable with respect to which differentiation is required (i.e., one of the several redundants).

It sometimes is possible in certain statically indeterminate problems to obtain the numerical expression of eq. (5) analytically by formal calculus integration of moment and stiffness functions [i.e., $M = f_1(s)$, $I = f_2(s)$]. However, in most practical cases, encountered in pressurized frame analysis, not only is it simpler but usually the only practical method to "strip-integrate" eq. (5) by tabular numerical integration.

Thus, considering the centroidal or nominal neutral axis of the frame of fig. 1 to be divided into a number of small finite increments of length Δs , simultaneous "elastic" equations (1), (2), and (3) are obtainable from the following tabular summations:

$$\begin{aligned} E \frac{\delta W}{\delta X_v} &= \sum_F M \left(\frac{\delta M}{\delta X_v} \right) \frac{\Delta S}{I} = 0 \quad (6) \\ E \frac{\delta W}{\delta X_n} &= \sum_F M \left(\frac{\delta M}{\delta X_n} \right) \frac{\Delta S}{I} = 0 \quad (7) \\ E \frac{\delta W}{\delta X_m} &= \sum_F M \left(\frac{\delta M}{\delta X_m} \right) \frac{\Delta S}{I} = 0 \quad (8) \end{aligned}$$

Of course, if both loading and structure of fig. 1 are symmetrical about the fuselage centerline, eq. (6) is eliminated entirely.

A numerical evaluation of these expressions yields (for the more general, unsymmetrical case) the following simultaneous equations:

$$\begin{aligned} E \frac{\delta W}{\delta X_v} &= AX_v + BX_n + CX_m + K_1 = 0 \quad (6a) \\ E \frac{\delta W}{\delta X_n} &= DX_v + EX_n + FX_m + K_2 = 0 \quad (7a) \\ E \frac{\delta W}{\delta X_m} &= GX_v + HX_n + JX_m + K_3 = 0 \quad (8a) \end{aligned}$$

where $A - J$ and $K_1 - K_3$ are constants obtained from the foregoing integration process.

By the use of a detailed deflection analysis (the Maxwell-Mohr method, for instance) and by the application of Maxwell's theorem of reciprocal deflections, it may be shown that in the above equations $B = D$, $C = G$, and $F = H$; or in other words, that the determinant of the system forms a symmetrical matrix (or may be ad-

(Continued on page 88)

WHAT'S UP... and WHAT'S GOING UP



Norwegian Airplane

The Wideroe C5 is a high-wing, single-engine plane of composite construction designed for charter, ambulance and photograph services. Seats six; grosses 4150 lb; cruises 130 mph; has a service ceiling of 18,000 ft; and range of 625 miles. Span is 45 ft, length 29 ft 6 in, and cabin capacity 180 cu ft. Powered by either 320-hp Wright Cyclone or 450-hp P & W Wasp Jr. Certificated for wheels, floats or skis.

British Amphibian

The Short Sealand has two 345-hp de Havilland Gipsy Queen engines. The second prototype will have 510-hp Alvis Leonides radials: Choice of power is left to the buyer. Top speed is 202 mph, cruising 184 mph and range with five passengers, at 127 mph, is 780 miles. Up to eight passengers and crew of two can be carried.



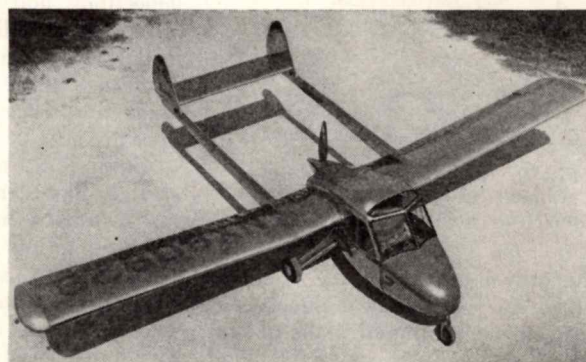
Baumann "Brigadier"

Baumann Aircraft's B-250 executive type plane is said to be well advanced in the CAA certification program. It has a gross weight of 3500 lb, 41-ft wing span and is designed to cruise better than 160 mph. It has two 145-hp Continental Engines driving pusher propellers. The plane will climb on either engine. Manufacturing plans are in the final stages for this five-place plane which is to sell for less than \$25,000.



Chase YC-122 Transport

Starting with a large all-metal glider design for the Air Force, Chase Aircraft hung two P & W R-2000 engines below the wing and flew the large cargo shell under its own power. Gross weight is 30,000 lb., payload 10,000 lb. It is expected to cruise at 200 mph for a 1000-mile range. Michael Stroukoff, its designer, claims that the greatest feature is the ability of the YC-122 to tow its glider counterpart, making a real air truck-trailer combination for assault-transport duties.

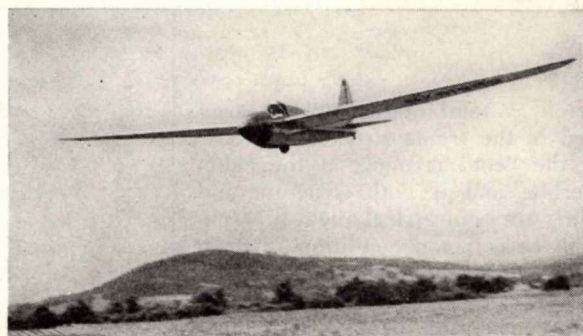


Boom-tailed Pusher

The Anderson Greenwood 14 is a full-cantilever, semi-highwing type with side-by-side seating for two. It is powered by a Continental C-90 engine connected directly with a pusher propeller. Occupants enjoy ease of entrance and exit from the ground, full forward and side vision and a great reduction in noise, due to the rear engine mounting. An accelerated-service test program is under way.

Briefs

Boeing Stratocruiser performance guarantees have been exceeded as indicated by the approved operating annual. . . . The first Air Force C-121 transport (Lockheed Constellation) is in test flight status. . . . Ryan, producing four each working day, delivered its 500th Navion—and has begun deliveries on the L-17B for the Army Field Forces and National Guard.



High-Performance Sailplane

Schweizer Aircraft Corp. announces production plans for the 1-23, Class I, all-metal sailplane. Wing span is 43 ft and the stabilizer measures 7 ft, small enough to be left on for road trailing. Design speed is 123 mph; minimum design-load factor 8.34 and weight 358 lb. Main structural fittings are 75ST alloy and the remainder 24ST Alclad. Sales price is \$2195; production will begin early this year and will be accomplished in runs of 20 aircraft.

TECHNICAL BRIEFS

of the National Advisory Committee for Aeronautics

Appreciation and Prediction of Flying Qualities. William H. Phillips. NACA Technical Note No. 1670, August 1948.—The extensive flight, wind-tunnel, and theoretical investigations of the stability and control characteristics of airplanes carried out during recent years have led to an improved understanding of this subject and to better correlation between the results of these three research methods. Some results of recent research that will aid airplane designers in selecting or modifying a configuration to provide satisfactory stability and control characteristics are summarized in this paper. The requirements of the NACA for satisfactory flying qualities, which specify the important stability and control characteristics of an airplane from the pilot's standpoint, are used as the main topics of the paper. The reasons for the requirements for satisfactory flying qualities of airplanes and of the influence of various design parameters on these characteristics are discussed. In addition, flight and wind-tunnel procedures used in the determination of flying qualities are explained. Sections deal specifically with longitudinal stability and control characteristics in straight and accelerated flight; types of control; directional stability and control characteristics; the characteristics of aileron control; stalling characteristics; control-free stability; wind tunnel tests; and other phases of the subject.

The Effect of Fuel Composition, Compression Pressure, and Fuel-Air Ratio on the Compression-Ignition Characteristics of Several Fuels. W. A. Leary, E. S. Taylor, C. F. Taylor, and J. U. Jovellanos. NACA Technical Note No. 1470, March 1948.—The variation in ignition delay and rate of pressure rise after compression was determined for iso-octane, 100-octane gasoline, triptane, and benzene. The tests were made with a rapid compression machine developed at M.I.T., and with fuel-air ratio and compression ratio as the only independent variables. In this study, special consideration is given to the pressure-time relations during the preliminary phases of a spontaneous combustion. The photographic records obtained suggest an explanation of the failure of benzene and triptane to detonate under engine conditions which caused iso-octane to detonate severely. Tests made to determine the effect of humidity, dust, and surface action on the ignition delay indicate that, except when the cylinder walls are coated with lubricating oil, no decided change is produced.

Investigation of Axial-Flow Fan and Compressor Rotors Designed for Three-Dimensional Flow. A. Kahane. NACA Technical Note No. 1652, July 1948.—This paper describes an investigation carried out to determine whether three-dimensional flows may be efficiently used in axial-flow fan and compressor rotors so that the spanwise load distribution may be suitably varied to obtain high pressure rise. Two rotors, one with approximately uniform and one with solid-body down-

A selection of recently published NACA Technical Notes, Technical Memoranda and hitherto Classified War-time Reports is herewith presented. Similar abstracts in other fields will be provided from time to time.

stream tangential-velocity distributions, were designed and tested at the design blade angle. Radial surveys of total pressure, static pressure, and flow angle were made upstream and downstream of the test rotors through a quantity-coefficient range. Tests of the solid-body rotor were also conducted at a large value of tip clearance. Conclusions drawn from the tests are that the three-dimensional flows may be utilized with high efficiency, that the three-dimensional theory used in conjunction with two-dimensional cascade data is sufficiently accurate for design purposes, and that the tip-clearance losses of rotors highly loaded at the tips are not excessive. A simplification of the existing three-dimensional theory and an illustrative rotor design are presented in appendixes.

Flight Measurements of the Longitudinal Stability, Stalling, and Lift Characteristics of an Airplane Having a 35° Sweepback Wing Without Slots and with 40-Percent-Span Slots and a Comparison With Wind-Tunnel Data. S. A. Sjöberg and J. P. Reeder. NACA Technical Note No. 1679, August 1948.—To determine the effects of sweepback on the low-speed flying qualities of an airplane, flight tests are being conducted at the Langley Laboratory with an airplane having a wing sweepback 85° at the quarter-chord line. This paper presents the static longitudinal stability, stalling, and lift characteristics for the test airplane without slots on the wing and also with slots extending along 40% of the span of the sweepback-wing panels. Longitudinal stability with the flaps up was high with or without slots throughout the speed range tested. With the flaps down, it was high at moderate speeds, but near the stall stability was neutral or slightly negative. Slots increased the stalling speed and therefore the speed range over which neutral or slightly negative stability was present. The stalling characteristics without slots on the wing were objectionable. Flight values of maximum normal-force coefficient were usually higher than wind-tunnel values.

Analysis of Flight-Performance Measurements on a Twisted, Plywood-Covered Helicopter Rotor in Various Flight Conditions. F. B. Gustafson and Alfred Gessow. NACA Technical Note No. 1595, June 1945.—Flight-performance measurements were made of a conventional single-rotor helicopter equipped with a test rotor having plywood-covered blades with -8° twist. Data were obtained in the hovering, vertical autorotative-descent, level-flight, climb, and autorotative-glide conditions. The results

of these tests are presented together with a comparison of the results with theoretical results and with results of measurements made on the original production rotor. Both the hovering- and the forward-flight performance of the alternate rotor were found to be within a few per cent of the values predicted by theoretical treatments already published by the NACA without any increase in the profile-drag characteristics originally assumed in the theory, provided that blade-section stalling was not present. The alternate rotor, as compared with the original rotor, showed large improvements in performance in all flight conditions for which a comparison was obtained. In general, about half of the improvement was considered to be due to improved airfoil-section contour and surface conditions of the alternate rotor blades, and most of the other half to the differences in twist and solidity.

A Metallurgical Investigation of Five Forged Gas-Turbine Discs of Timken Alloy. J. W. Freeman, E. E. Reynolds, and A. E. White. NACA Technical Note No. 1531, June 1948.—A previous investigation has shown that the properties of heat resisting alloys for turbo-supercharger and gas-turbine applications largely depend on the conditions of fabrication. This paper reports the results of tests carried out to determine the reproducibility of properties from disc to disc made by different companies and to investigate the effect of various fabrication procedures on the disc properties. The data obtained indicate that Timken alloy discs which are hot-cold worked after hot-forging and made from different heats by different companies will have similar properties. The properties of the discs are lower than those of similarly processed bar stock on the basis of tensile and rupture characteristics. Comparison on the basis of rupture strength showed the Timken discs to be better than a CSA alloy disc, similar to a 19-9DL disc, but not so good as a low-carbon N-155 alloy disc.

Analytical and Experimental Performance of an Explosion-Cycle Combustion Chamber for a Jet-Propulsion Engine. Morris A. Zipkin and George W. Lewis, Jr. NACA Technical Note No. 1702, September 1948.—Use of the constant-volume cycle offers, at least theoretically, a means of improving jet-engine performance. The actual performance would depend on the extent to which constant volume could be approached and the resulting explosion pressure developed in the combustion chamber. This paper describes an investigation of the performance of an explosion-cycle com-

bustion chamber, which serves as an indication of the performance that can be expected from a jet engine utilizing this cycle. Calculated and experimentally-determined explosion-pressure ratios obtained in a combustion chamber with a timed inlet valve and several fixed-area exhaust nozzles are presented over a range of fuel-air ratios. The effects of variation in cycle frequency and inlet pressure are investigated. Maximum experimental values of explosion-pressure ratio and jet thrust were approximately 2.9 and 35 pounds per pound of air per second, respectively, and occurred at an over-all fuel air ratio of about 0.04.

Analysis of the Performance of a Jet Engine from Characteristics of the Components: II—Interaction of the Components as Determined from Engine Operation. Arthur W. Goldstein, Sumner Alpert, William Beede, and Karl Kovach. NACA Technical Note No. 1701, September 1948.—A method of analysis has been developed, for application to jet-propulsion engines, which clearly shows the operation of the compressor and turbine components under all conditions of engine operation and permits the estimation of the effect on engine performance of modifications in the performance characteristics of the engine components. The method was used to evaluate applicability data from cold-air investigations of the turbine component to predict engine performance, to predict the performance of a modified engine, to determine engine and component operation as a hot-gas generator for a power turbine, to determine the performance of a complete turbine-propeller engine, and to explain some phenomena of turbojet-engine operation.

Flight Investigation of Effects of Rotor-Blade Twist on Helicopter Performance in the High-Speed and Vertical - Autorotative - Descent Conditions. Alfred Gessow. NACA Technical Note No. 1666, August 1948.—Rotor-blade twist has been advocated as an effective means of minimizing the adverse effects of stalling of the retreating blade of a helicopter rotor traveling at high tip-speed ratios. To determine the effects of rotor-blade twist on helicopter performance, measurements were made on an untwisted, plywood-covered rotor in high-speed and vertical - autorotative - descent conditions and the results compared with measurements on a similar rotor having 8° of linear wash-out and with theoretical calculations. It was found that negative blade twist appears to be an effective means for increasing the maximum speed of the helicopter as limited by blade stall, and for reducing the performance losses due to stall at a given thrust coefficient and tip-speed ratio. A comparison of the test results with both rotors in vertical power-off descent showed that the negative blade twist had little effect on the performance of the helicopter in that condition. The same conclusion appeared to be true for the forward-flight glide condition as well.

TWO PROSPECTIVE MILITARY TRAINERS

SURELY mindful of the large numbers of training planes required for the military during the past war while studying the national security picture, Beech Aircraft and Douglas Aircraft made almost simultaneous announcements of trainer developments in their shops.

The Beech Model 45 *Mentor* has made its initial flights and is being groomed for a demonstration tour of

the military air services, in addition to a low-cost airplane, a high-performance trainer incorporating the controls and characteristics of the heavier combat aircraft. It has an ultimate load factor of 10 for maneuvers and 6.67 for landing.

High speed at sea level is 176 mph; normal cruising at 10,000 ft and 61% power is 160 mph; maximum IAS while diving is 280 mph; range at

inside the fuselage immediately aft of the cockpit. An extension shaft drives the tractor propeller.

An evaluation design for the Air Force, the XT-30 features unobstructed forward and downward visibility in the best jet-fighter tradition; a high aerodynamic efficiency; and ready accessibility to the engine and accessories for maintenance. In fact, a maintenance crew has removed and installed the engine in a little more than 20 minutes after five earlier trials for experience.

The plane is heavy; it grosses 5999 lb. It is a conventional low-wing model with a span of 36 ft 4 in., length 36 ft 9½ in and height 13 ft 6½ in. Flying at full gross weight, the XT-30 is expected to have a top speed of 286 mph



Low-cost primary and basic-advanced trainer proposed by Beechcraft as an "off-the-shelf" design which would use existing tooling and much non-strategic material

military establishments around the country. It is a single-engine, all-metal, two-place, low-wing job, strongly resembling the *Bonanza*, although the *Mentor* has the conventional single vertical-tail surface.

Like the *Bonanza*, it is powered by the Continental E-185 engine. Its designers regard it as an "off-the-shelf" primary and basic-advanced trainer because many *Bonanza* parts are interchangeable and because no complete new tooling and parts setup would be required—not only making for almost immediate deliveries but also bringing the price down to the point where the Government budgeteers would be happy too.

Walter H. Beech, Beechcraft prexy, estimates that his company can deliver this trainer in quantities for less than \$20,000 complete. And he stresses operating economies too, low fuel consumption as well as a lot of Beechcraft maintenance know-how spread through dealerships all over the country—which could be brought into play in an emergency.

The design philosophy is to offer

cruising is 634 miles; service ceiling is 18,000 ft; fuel consumption is 10 gph; and gross weight 2650 lb.

There are two powerful factors in favor of this design. A large percentage of the material going into the Model 45 *Mentor* is claimed to be "non-strategic." And (the appropriations boys will applaud again) this potential trainer design was financed privately by its originators.

Douglas designers reiterated their faith in the submerged engine installation by developing the XT-30, powered by an 800-hp Wright *Cyclone* installed

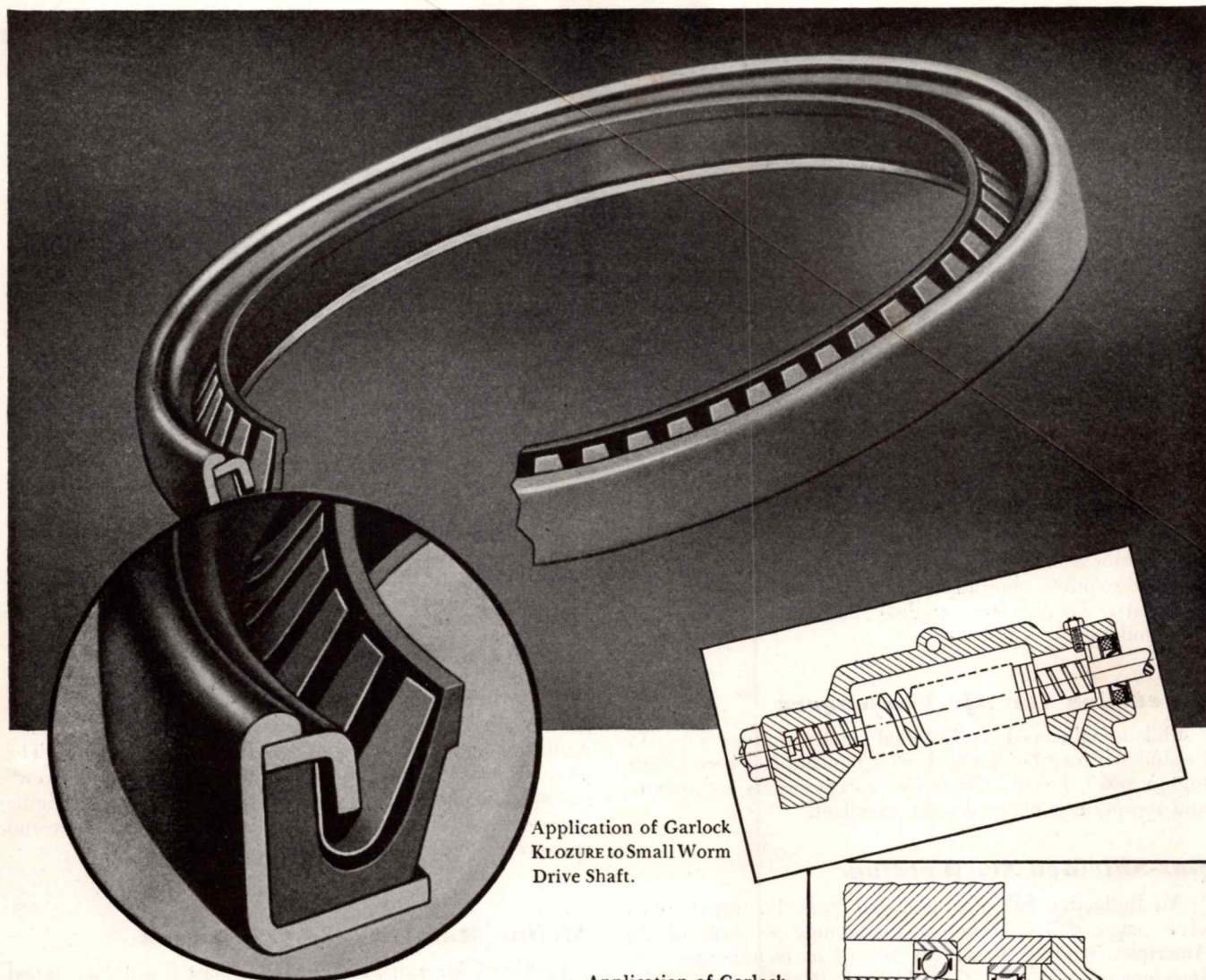
at 10,000 ft and a cruising speed of 190 mph for a 6¼-hr range. Service ceiling is 29,600 ft.

Submerging of the powerplant within the fuselage moves the *cg* well to the rear of the aircraft, providing excellent visibility for student and instructor. It also makes for better streamlining around the nose and provides for a longer wheelbase of the tricycle gear to achieve greater ground stability.

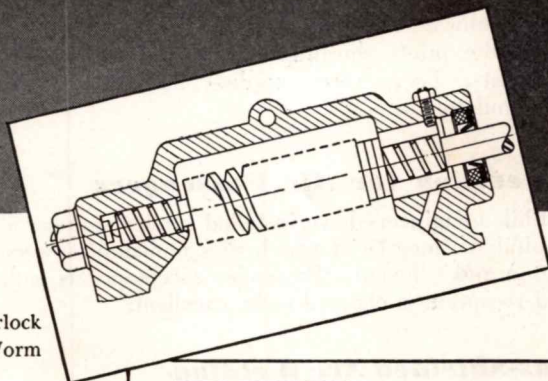
The plane would be used for gunnery as well as flight training. A full-scale mockup and an operating engine test stand have been built.



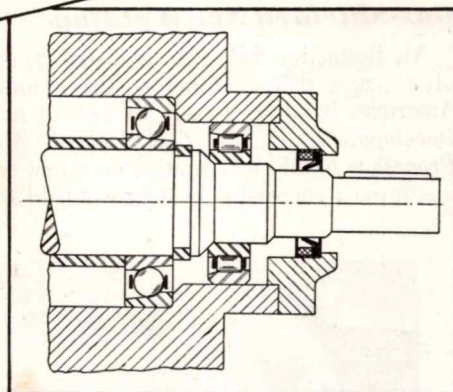
Mockup of Douglas XT-30, proposed Air Force trainer. Radial engine is inside fuselage behind cockpit; can be removed in a few minutes. Student and instructor enjoy full visibility



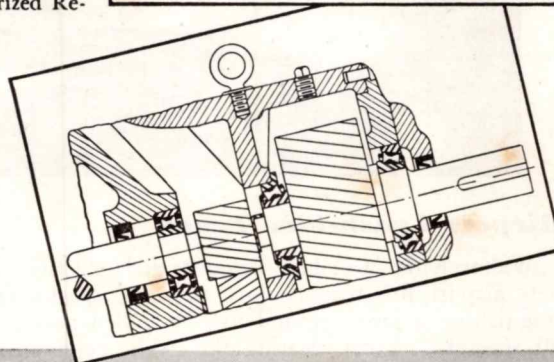
Application of Garlock KLOZURE to Small Worm Drive Shaft.



Application of Garlock KLOZURE to Piston-Type Pump Drive.

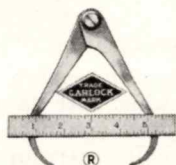


Application of Garlock KLOZURE to Double Reduction Motorized Reducer.



A Superior Oil Seal

The new Garlock Models 53 and 63 KLOZURE Oil Seals are constructed with light, uniform and positive spring loading for extreme sensitivity and flexibility. They seal bearings efficiently at high or low shaft speeds, even on shafts having considerable "whip" or lateral movement. The exclusive sealing element resists heat and oil, has a low coefficient of friction and is tough, durable and resilient. Write for KLOZURE catalog.



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TAKEOFFS AND TURNS

Bibliography on Industrial Radiology

St. John X-Ray Laboratory, Califon, N. J., announces the second supplement to *Industrial Radiology*, published in 1943. The first supplement was issued in 1945. The new addenda sells for \$2.

Approach Lights for "Vittles" Run

Forty high-intensity lights mark the approaches to the main runway of Templehof Air Force Base, Berlin, to assist the pilots shuttling supplies to the blockaded inhabitants. They were supplied by the American Gas Accumulator Co.

Television for Air Passengers

Phileo engineers have installed a television set aboard a Capital Airlines DC-4 which flies non-stop between Washington and Chicago. Passenger acceptance is enthusiastic and reception is claimed to be excellent.

Gas-Shielded Arc Welding

Air Reduction Sales Co. is distributing illustrated copies of a paper delivered before the annual meeting of the American Welding Society by two of its technicians. *The Development of the Gas-Shielded Metal Arc-Welding Process* is highly informative on a new welding idea which has proved successful in a broad field of application.

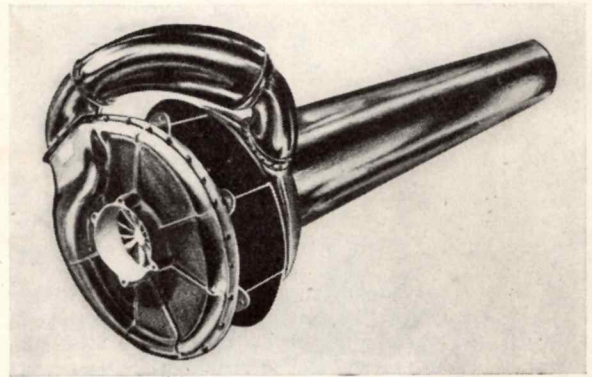


Airport Crash-Fire Truck

Walter Kidde Co. has demonstrated effectiveness of its new airport fire truck before industry spectators by extinguishing a large ground fire of spilled gasoline within 30 seconds. Truck carries 12 100-lb cylinders of CO₂, new-type nozzles and long lengths of hose. Kidde is also seeking approval of its extinguishing agent called CB, which is designed to replace the highly toxic and corrosive methyl bromide for use against aircraft engine fires.

"One-Lunger" Turbojet

An Engineering School project of the Cal-Aero Technical Institute is a 175-lb turbojet being developed as a



powerplant for the single-place jet lightplane also being designed and built by students of the Institute. The photo shows the basic engine and its single "corkscrew" combustion chamber, without intake ducting and engine accessories. It is built around a type "B" supercharger and is expected to develop 240 lb thrust.

Airline Maintenance Contracted

Lockheed Aircraft Service (East Coast Base) has signed a mile-maintenance agreement with Island Air Ferries for the entire maintenance and overhaul of the newly certificated airline. Both companies are based on McArthur Airport, Long Island.

Anniversary Open House

Allegheny Ludlum Steel Corp. recently held a unique simultaneous open house at two widely-separated plants, playing host to almost 40,000 persons. Each program was turned into a community-wide celebration; a formal customers' products exhibition was included; and company stockholders were invited to attend, wearing identification armbands.

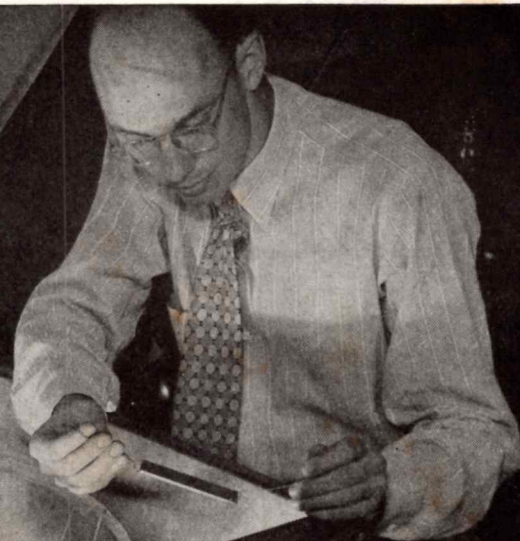
Experimental Omni Chart

The Coast and Geodetic Survey has released an experimental edition of an aeronautical chart showing VHF facilities between Chicago and New York. Chart was produced in cooperation with RTCA and has modified terrain features to permit greater emphasis on Omni information.

Continuous-Flow Fuel System

A Wright Field technician has devised a system for aircraft which provides an automatic flow from all tanks to all engines without manual attention. It also permits rapid refueling of all tanks from a single, easily-accessible point on the plane. It is being incorporated into current large and medium bombers.

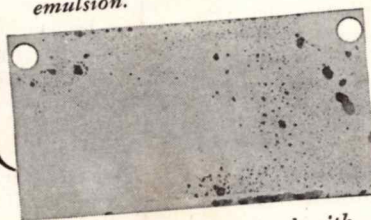
Gulf **Soluble Cutting Oil** gives better protection against rust



Look at these
unretouched photos
of samples after
humidity cabinet test



*This sample was coated with
Gulf Soluble Cutting Oil
emulsion.*



*This sample was coated with
emulsion of an ordinary solu-
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Here's protection for metal parts being machined in your shop! The excellent rust preventive properties of Gulf Soluble Cutting Oil prevent rust formation between processes or when the job is left on the machine. It keeps highly finished surfaces bright longer!

The two samples shown above tell the story! Both have been exposed to a controlled flow of 120°F. air saturated with water (Relative Humidity—100%) for a period of more than two hours.

Note the startling difference! The sample coated with an emulsion of Gulf Soluble Cutting Oil shows no signs of rust formation even at the

plate corners, which are more difficult to protect. The sample coated with an ordinary soluble oil emulsion is spotted with rust marks, many of which have marred the surface permanently.

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TWA Prize Again for Silsbee

Fifteen men and women from seven cities won first, second and third place honors in Trans World Airline's 11th Annual Aviation Writing and Picture Competition. The judges were authors Bruce Barton, Clarence Buddington Kelland and Gene Fowler, and E. O. Cocke, TWA vice-president of traffic. The prize-winning material was selected from a record-breaking number of entries.

First place winner in the Technical Class—Nathaniel F. Silsbee, Managing Editor, *AERO DIGEST* magazine. This is the second time he has placed first in this class in the TWA annual competition, having won the award and trophy last year. The judges' comments: "This writer stood out above others for breezy style, clear reporting and ability to wade into highly technical subjects and keep them

interesting." Of course, this included jets.

The other first place winners: Newspapers, Open Class—Robert Sibley, Aviation Editor, *Boston Traveler*. Newspapers, Selective Class (100,000 circulation or less)—Mary L. Hobar, now on *Pittsburgh Post-Gazette*. Magazine & Book Class—Robert S. Ball and Spencer A. Larsen, Detroit, Mich., who submitted a book on marketing of seafoods through air transportation. Photographic Class—Joseph Costa of King Features.

All the winners except two spent a delightful TWA "Quickie Vacation" in the Southwest over the weekend of Dec. 10-12, during which they and a group of travel editors were guests of TWA and the resort owners and chambers of commerce of Phoenix and Wickenburg, Ariz., and Las Vegas, Nev.

LANDING A HELICOPTER, ENGINE OFF

(Continued from page 51)

forward speed of approximately 40 *mph* for desired rate of descent. When the ground clearance is approximately 35 *ft*, a flare should be executed by pulling back on the stick to decrease speed to approximately 35 *mph*. The stick may then be moved forward to lower the nose to a level position and to eliminate the possibility of dragging the tail rotor. The succeeding descent to the ground may be controlled by pulling up on the main pitch to permit a normal landing at a contact speed of approximately 20 *mph*."

Floyd Carlson tells us that at Bell Aircraft thousands of autorotative landings have been safely and simply made

and gives the following excellent statement on Bell practice:

"We consider that it is easier to make an autorotative landing in a helicopter than it is to make a normal landing in a fixed wing airplane! This may sound like sales propaganda, but I believe that this feeling stems from the public's lack of knowledge as to what the present-day helicopter is capable of doing. There is no doubt a difference in techniques required due to the various designs of the helicopters which the pilot must consider when he is executing a dead-engine landing. However, the commercial helicopters in operation today do not require a great deal of variation in pilot technique.

"Essentially there are two types of autorotative landing techniques which are in use today. To explain them briefly, the No. 1 technique, which is relatively simple and is generally taught to the student first since it taxes his ability the least, merely involves maintaining a constant airspeed which has a value within the range of minimum rate of descent speed (in the Bell helicopter we have set 30 *mph*, IAS). The collective pitch remains in the full down position during the glide but is increased when nearing the ground at the proper rate to cushion the landing. We have found that this technique is easily learned by the student pilot.

"The only difficulty experienced has

been with the fixed-wing pilot who has a tendency to bring the nose up when he is near the ground in an attempt to flare out for his landing. This is obviously a carry-over from his fixed-wing flying experience and he therefore has difficulty in overcoming this tendency. It is essential that he not do that in the helicopter, since landing in a tail-low attitude results in the hazard of striking the tail rotor.

"The other technique is one which requires the pilot to maintain on his final approach an airspeed of sufficient value to make a flare effective. (Above 40 *mph* in the Bell helicopter.) This flare is executed at an altitude of approximately 25 *ft* to eliminate the hazard of striking the tail boom. The execution of the flare reduces the rate of descent considerably, as well as reducing the airspeed. Assuming that the helicopter has now reached an indicated airspeed of zero *mph* and has no rate of descent, the pilot can bring the nose back to the horizon by forward application of the cyclic control and allow the aircraft to sink vertically. Since he has only 25 *ft* of altitude there is insufficient time for the machine to reach the stabilized rate of descent for this airspeed; therefore it is not difficult for the pilot to check the rate of descent, which has been attained, by use of the collective pitch in the same manner as it was applied in the technique described above."

The British in their training program offer two variants. In *fig. 3*, after the pull-out from a high glide speed, the machine floats, as previously mentioned, for 3 *sec* to 6 *sec*. The pilot has plenty of time "to think about it" and to correct gross errors in the height of the pull-out. Also, by a pull-up on the collective pitch control he can get an extra float before letting his machine down at not more than a walking pace. The procedure of *fig. 2* gives the least chance of landing damage and has the added advantage of clearly separating each part of the landing process in the mind of the student pilot. Hundreds of such landings have been made in British training with perfect success.

Fig. 4 shows a slow approach glide, from say 40 *mph*. Though this appears more difficult at first than the high-speed approach glide because there is less kinetic energy to play with, experience indicates that the slower approach is better.

Apparently there is not much difficulty left in making power-off landings. In landing from a high-speed approach glide, and with a subsequent float (one of the British methods), the chance of a poor landing is quite remote. In American practice with more modern machines, there is no difficulty in landing from a steeper, slower glide and meeting the ground gently at a forward speed of some 20 *mph*.

EDITORIAL

(Continued from page 5)

as president of the Daniel and Florence Guggenheim Foundation, has grasped this fully. He decided quite rightly that the best plan was to establish centers of research and study in rocket and jet propulsion. He selected Princeton and California Institute of Technology after the most careful survey.

The Foundation has underwritten the two jet-propulsion centers for a period of seven years and has appropriated \$500,000 for the purpose. The principal post at each center will be a Robert H. Goddard Professorship, named in honor of the American pioneer, whose great work the Guggenheim Fund for the Promotion of Aeronautics had also fostered.

We consider the establishment of these centers of the utmost value and significance to the nation and congratulate Mr. Guggenheim on his wisdom and farsightedness. —F. A. T.

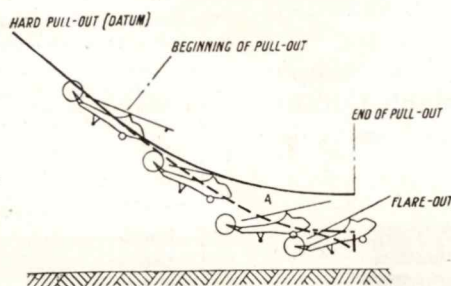
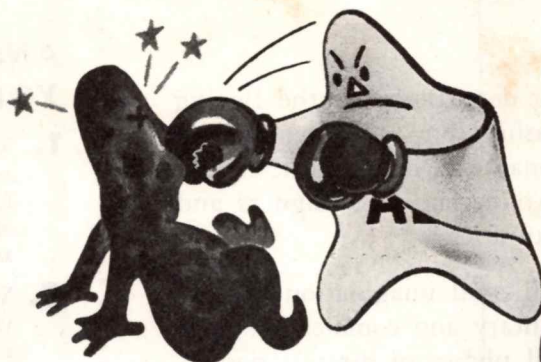


Figure 4

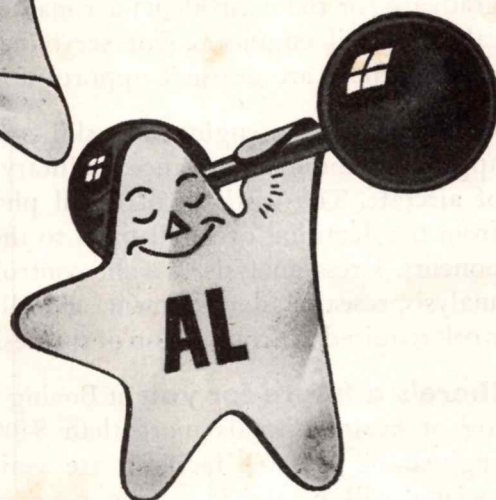
Heat



Corrosion



Great Stress



—they all look alike to **ALLEGHENY METAL**

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(Solid and Clad)**

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A lifetime servant that can stand up to your job—practically under *any* conditions of heat, corrosion and wear—that's what you get when you specify Allegheny Metal. Great strength and resistance to chemical or atmospheric corrosion . . . rugged ability to take a beating . . . bright, shining beauty and endless ease of cleaning . . . they're all yours with this time-tested stainless steel.

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Exceptional Opportunities for DESIGN ENGINEERS

Right now—in the engineering department of the Boeing Airplane Company in Seattle, Washington—are openings for graduate (or the equivalent) aeronautical, mechanical, electrical, and civil engineers. For servo-mechanism designers and analysts there are unusual opportunities.

At Boeing your engineering skill and imagination will be applied to the most advanced military and commercial types of aircraft. The work involves all phases of aircraft design, from the detailing of small parts to the layout of major components, stress analysis, weight control, vibration and flutter analysis, research, development, and all associated engineering work required for completion of the design of the final product.

There's a future for you at Boeing where the current backlog of business totals more than \$400,000,000. Outstanding engineering research facilities are available to you. Your associates will be the men who have contributed to Boeing's reputation for leadership in aviation research, design and engineering.

To all these advantages that Boeing offers you, add the fact that living is pleasant in the Pacific Northwest. No extremes of heat and cold. A wide variety of recreation is available the year round—fresh and salt water sailing and fishing, skiing, golf, and mountain climbing.

Similar openings are available in the Boeing-Wichita, Kansas plant. Inquiries indicating a preference for Wichita assignment will be referred to the Wichita Division.

For an illustrated brochure, "As the Twig is Bent," on Boeing engineering, and additional information about the opportunities discussed here, write "Personnel Office, Engineering Division, Boeing Airplane Company, 7750 E. Marginal Way, Seattle 14, Washington."

For the Air Force, Boeing is building the B-50 bomber, XB-47 jet bomber and C-97 transport; for the Army, the L-15 liaison plane; and for six major airlines, the twin-deck Boeing Stratocruiser.



ANSWERING YOUR QUESTIONS

1. What about housing? *Recent new employees have had no difficulty. Our Personnel Unit will give you all possible assistance in finding suitable housing.*
2. What are opportunities for advancement? *Opportunities in all engineering units are virtually unlimited and depend primarily on training, ability and application of the individual.*
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5. Is there a formal school or training program? *New engineers are normally placed in a group commensurate with their qualifications. A short training program carried on concurrently with design assignments is given for familiarization with Boeing procedures and practices.*

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1. Two weeks vacation with pay.
2. Ten days sick leave per year — if necessary.
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4. Low cost accident and health insurance.
5. Unusually attractive group life insurance.

BOEING



AERO EQUIPMENT and TRADE LITERATURE DIGEST



Light Aircraft Oil Filter

A-2

Fram PB5 filter is especially designed for engines not exceeding 335 cu in displacement. Small over-all design permits mount-

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ing on average lightplane firewall; two outlets provided to facilitate installation. Removes sludge, dirt and abrasives; lengthens engine life; shortens engine cleaning time during overhauls.

Air Associates, Inc.
Teterboro, N. J.

Portable Power Shear

A-4

The 12-gage *Porto-Shear* is said to cut 12-gage standard sheet steel, two gages thinner in Monel and stainless and approximately 50% more in copper, aluminum and other non-ferrous metals. Cutting blade always visible, makes a smooth cut and will cut on a radius as small as 1½ in.

The Black & Decker Mfg. Co.
Towson 4, Md.



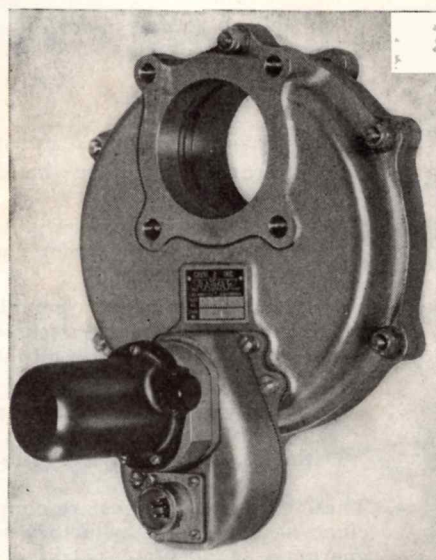
Crew Seats

A-3

Comfortable chairs for crews manning the long-range Convair XP5Y. Pilot and co-pilot seats are adjustable in the usual manner and have head-rests for more restful relaxation.

Crew chairs are well padded, have padded arm-rests, can be raised and lowered and are swiveling.

Weber Aircraft Div.
Weber Showcase & Fixture Co. Inc.
2001 Belgrave Ave.
Huntington Park, Calif.



Fuel Shut-Off Valve

A-1

Shear-Seal motor-operated valve features high capacity and controlled actuation. Designed especially for rapid refueling in flight, is also suitable for use in single-point refueling systems. Working pressure is 60 psi; operates on 22-28 v d-c; permits use of indicator lights. Units for 1¼, 1½, 2 and 3½-in sizes are available. Adapted to hydraulic oil, water, lubricating oil, and hot air.

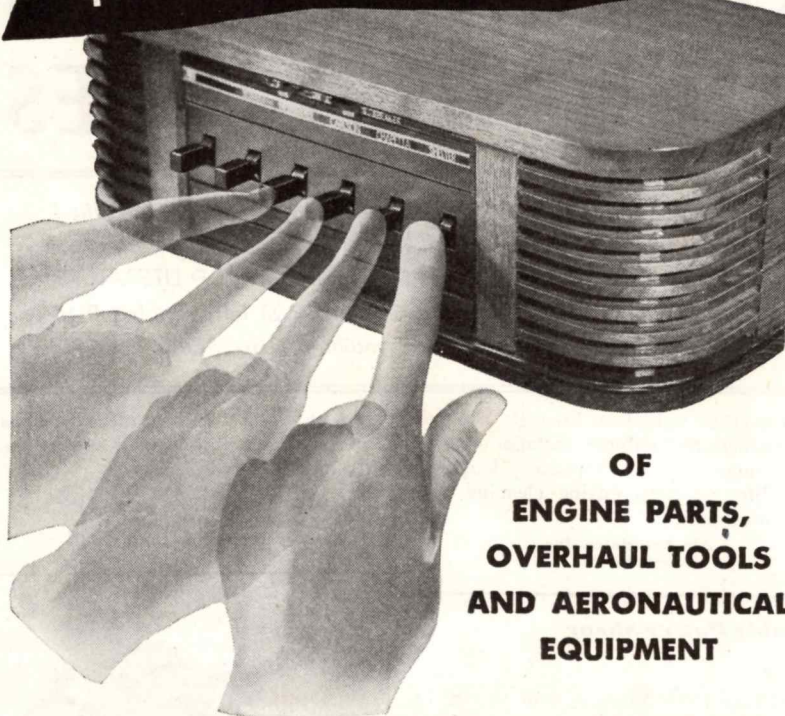
Saval, Inc.
1915 East 51st St.
Los Angeles 11, Calif.

Oxygen Breathing Unit

A-5

"Packaged" unit designed for commercial airline use for passengers and crew at high altitudes. Now available for executive and
(Continued on following page)

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P.S. AE&P is currently purchasing for several airlines abroad all of their material requirements.

(Continued from preceding page)

corporation business planes as a complete oxygen system ready for instant use. Comes fully charged; included is a connection for refill from standard cylinders; duration of operation at 15,000 ft ranges up to five hours for the pilot alone.

Scott Aviation Corp.
Lancaster, N. Y.



Low-Cost Fire Extinguisher A-6

Hero is a lightweight, sealed unit which throws a stream for 18 ft. Requires no inspection, ever; cannot leak; has mounting bracket, good for incipient fires anywhere.

Bostwick Laboratories
Bridgeport, 5, Conn.

Safety and Code Flashers A-11

Types include two-circuit position light flashers, single-circuit flashers and code flashers for the military, for use where radio silence may be a requisite. Use has been extended to personal planes for greater night-flight safety.

Texas Engineering & Mfg. Co.
Dallas, Tex.

Air-Cylinder Catalog A-12

Eight-page engineering bulletin giving complete design, construction and mounting data on a standard line of mill-type air cylinders. Described are single- and double-rod end, non-rotating models, with or without cushions and with choice of piston-rod diameters.

Miller Motor Co.
4027 N. Kedzie Ave.
Chicago 18, Ill.

Luminous Paints A-23

Reprint of an article, *Seven Competitors*, focuses attention on the possibilities and usefulness of luminous paints in industry and how their worth is being brought to public attention.

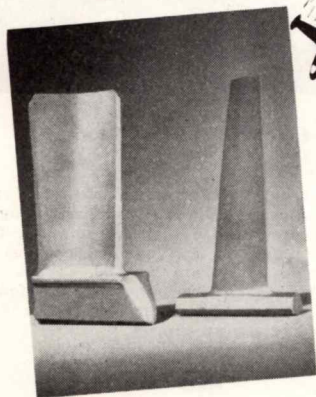
New Jersey Zinc Co.
160 Front St.
New York 7, N. Y.

Tool Steel Selection Chart A-24

Wall chart containing a 12-color reproduction of the Carpenter Matched Set Diagram. Shows the tool and die maker how to use Diagram to select the proper steel for each job.

The Carpenter Steel Co.
316 W. Bern Street
Reading, Pa.

Precision Forged Turbine and Compressor BLADES



Eliminate costly machining . . . save time and money . . . with **PRECISION FORGINGS**. Turbine blades, for example, can be forged to exact specifications . . . rugged to withstand high stresses at red heat . . . airfoil sections perfectly forged for efficiency—all without costly, time-consuming machining!

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It's a new, modern, completely contained unit designed to produce precision forgings only. Modern techniques and controls assure quality through laboratory regulated thermal procedures. And it can be working for YOU! Inquire now.

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Famous for 50 years, Utica Tools are the leaders in the exacting field of aviation production and maintenance!

PRECISION FORGINGS DIVISION

UTICA
DROP FORGE and TOOL
CORPORATION
UTICA 4, N.Y.

Electric Pattern Processes

A-7

Kenyon KIS, KDP and KSR processes of fine-definition photography offer methods of producing on a variety of base materials electrically conductive or resistive patterns with a dimension accuracy of 0.0002 in.

Kenyon Instrument Co.
1345 New York Ave.
Huntington Station, N.Y.

Fiber-Glass-Plastic Combination

A-25

Synspun impregnates glass fibers in a swirling design with tough, firm synthetic resins. It is thermoplastic, may be sewn, laced, glued, riveted, corrugated and fluted; may be bonded by using electronic equipment.

Polyplastex United, Inc.
92-35 Horace Harding Blvd.
Elmhurst, N. Y.

Battery Charge Indicator

A-33

Indicator for battery-powered industrial trucks which mounts on dash in front of the operator. State of charge is visible at all times; tamper-proof.

Gould Storage Battery Corp.
Trenton, N. J.

Portable Electric Polishers

A-34

Standard and *Automatic* models have been re-designed for greater power and more ease in operation. The *Automatic* is built to feed a cleaning liquid through the hollow spindle to the work.

Van Dorn Electric Tool Co.
Towson 4, Md.

Impact Wrench

A-35

First of a new line of portable electric wrenches to tighten or remove either right- or left-hand nuts, bolts and cap screws. Rated at $\frac{3}{8}$ -in thread diameter; light in weight and minor torque reaction.

Black & Decker Mfg. Co.
Towson 4, Md.

Flexible Template

A-36

Maker claims new template to duplicate complex curves and eliminate template making. Sets and locks into any desired shape, contour, curve or radius and can be transferred anywhere. Springs back to original position when unlocked.

R. J. Turner Co. Inc.
2404 N. Mascher St.
Phila. 33, Pa.

Flame-Resistant Finishes

A-10

Skylac aircraft lacquers for interiors and exteriors which are said to be highly flame-resistant and yet retain a high gloss and durability. Now available for personal aircraft.

Monsanto Chemical Co.
Merrimac Div.
Everett, Mass.

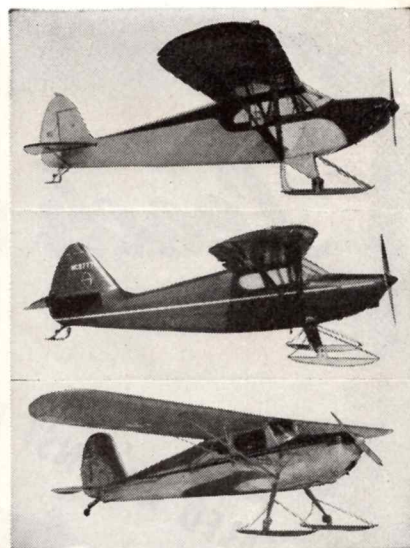
Safety Press Control

A-27

Microtrip is a two-hand electrical switching circuit for the safe control of tripping mechanisms on presses, shears, riveters and spot welders. Light touch actuates; cannot be "cheated."

Micro Switch
Freeport, Ill.

(Continued on following page)



Equip with **FEDERAL** ALL-METAL SKIS

Increase Airplane Revenue

In winter, many new sources of income from Ski-plane operations are possible. Organized hunting, fishing, skiing, sleighing and other winter sporting events, will add new flying pleasure and stimulate enthusiasm for year around flying.

Increase Airplane Sales

Business concerns, farmers and ranchers can be interested in airplane ownership as a business necessity when shown that it is practical, economical, and safe summer and WINTER.

Go to businessmen in your community. Analyze their personnel travel requirements. Tell them how an airplane will economically, safely and conveniently handle transportation of personnel at low cost and minimum travel time.

Increase Airplane Rentals

Don't let snow stop winter flying operations. Equip your planes with skis and make winter flying hours turn in a profit. Stimulate winter flying interest among students, pilots, sportsmen, businessmen, salesmen, field servicemen, etc. who do not own their airplane. Encourage, more charter trips for sales, service, emergency deliveries.

When heavy snowfalls stop other means of transportation, you can get there with airplanes equipped with Federal skis.

Increase Student Training

There are more good flying hours in winter, for airplanes equipped with skis than in summer for airplanes equipped with wheels. Encourage and promote student flying through the winter months, when other outdoor activities are minimized. Organize social groups among high schools, colleges and business concerns. Have them meet socially at the airport. By providing entertainment facilities, you can stimulate interest in winter flying. A few meetings and demonstrations of the fun of flying in the winter on skis will keep your planes flying profitably throughout the winter.

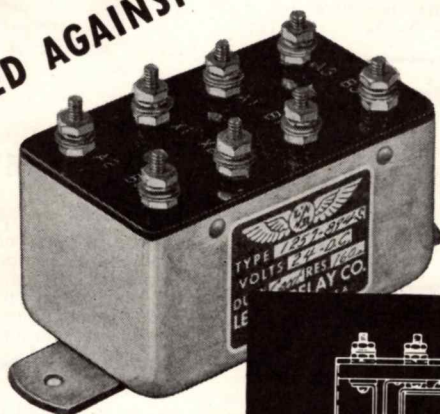
Increase Flying Safety

Federal Skis are low cost insurance. Almost any area large enough to land an airplane is a safe and satisfactory landing field in winter for ski equipped aircraft.

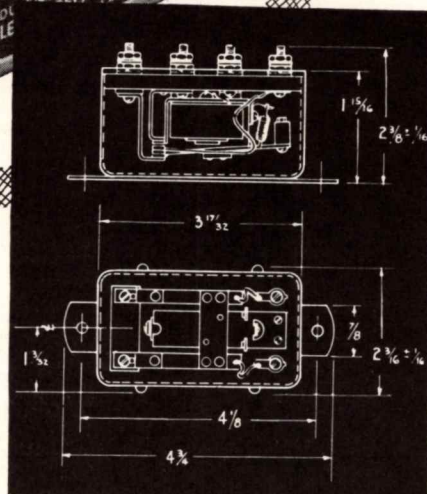
FEDERAL
AIRCRAFT WORKS
MINNEAPOLIS 12, MINN.

Leach RELAYS

SEALED AGAINST EXPLOSIVE MIXTURES



Explosion proof...



THESE RELAYS are effectively sealed by an elastic compound which prevents explosive mixtures from entering the contact chamber. This seal is resistant to extreme temperature changes, as well as the effects of aircraft vibrations. The type illustrated is furnished with an aluminum cover so fixed to the bakelite base that the relay is made tamperproof.

Leach manufactures a broad line of AN relays and approved substitutes for AN relays. Write today for complete information.

For Better Controls Through Better Relays Look To Leach

LEACH RELAY CO.

5915 AVALON BOULEVARD ★ LOS ANGELES 15, CALIFORNIA

(Continued from preceding page)



Dry Chemical Fire Truck

A-28

Claimed to be the first motorized fire truck to use dry chemical as the primary extinguishing agent; provides the best in protection for airports, refineries and other operations where flammable liquids are handled. Carries 2800 lb dry chemical and 250 gal water; has four-wheel drive; extra side compartments house firefighting and rescue accessories.

Ansul Chemical Co.
Fire Extinguisher Div.
Marinette, Wis.

Valve Refacer

A-8

Model 100 features wet grinding with a double coolant sump to provide better coolant settling and protection to valve and grinding wheel. Will handle valves up to 5-in head diameter.

Vickers Inc.
Waterbury, Conn.

Coated Tubing

A-9

Varglas Permaflu Tubing has a synthetic coating which is relatively immune to alcohol, petroleum and aromatic hydrocarbons. Is tough and has a high degree of insulating qualities even after severe bending, wrapping and twisting.

Varfex Corp.
Rome, N.Y.

Welding Press

A-29

Spot Welding press capable of handling large, complicated sections swiftly and efficiently. Several welds can be done at the same time; operation automatically controlled.

Clearing Machine Corp.
6499 West 65th St.
Chicago 38, Ill.

Improved Piston Ring

A-30

Top compression ring made of K-Spun metal, centrifugally cast, is said to possess 50% more spring and four times the resistance to combustion shock. Already tested in aircraft and automotive fleets, K-Spun will be incorporated in 1949 piston-ring sets.

Koppers Co. Inc.
Metal Products Div.
Piston Ring Dept.
Baltimore, Md.

VHF Receiver

A-31

NARCO VRA-1 receiver is lightweight equipment designed under CAA contract; may be tuned to any channel between 108 mc and 122 mc, including localizers, range signals, omni ranges, airways communications, approach control and towers.

National Aeronautical Corp.
Wings Field
Ambler, Pa.

Valve Refacer

A-32

Thor 99 is designed for precision, wet grinding; has double-grip collet, speed chuck and grinds at all standard angles; extra heavy construction; automatic bearing compensation.

Independent Pneumatic Tool Co.
175 State St.
Aurora, Ill.

TRADE LITERATURE

See Instructions on Page 73 for
Obtaining Additional Information

Electrical Connection Markers

A-44

Illustrated bulletin describes *Hi-Heat* labels which will not curl, dry out or fall off, according to the maker. Not affected by heat, cold, moisture or vibration.

W. H. Brady Co.
808 North Third St.
Milwaukee 3, Wis.

Analytical Instruments

A-45

Catalog CEC-1300A illustrates and describes in detail mass spectrometers, pressure and vacuum leak detectors, static-dynamic measuring and recording instruments, recording oscillographs, galvanometers and vibration pickups and meters.

Consolidated Engineering Corp.
620 North Lake Ave.
Pasadena 4, Calif.

Portable Multi-Purpose Tool

A-26

Maker claims the D-6 electric-powered tool to be designed for tough jobs in industry; it will grind, polish, drill and cut by making a simple change of attachments. Weighs less than 6 lb and can be operated in any position.

Porter-Cable Machine Co.
1714 N. Salina St.
Syracuse 8, N. Y.

Flexible-Metal Coolant Hose

A-46

Bulletin describes *Stay-Put* hose designed especially for conducting coolants on machine tools. Said to combine ready adjustability with maintenance of position on the work.

Chicago Metal Hose Corp.
Maywood, Ill.

Rubber Expansion Joints

A-13

Eight-page, illustrated bulletin on expansion joints—flexible rubber connections installed in pipe lines to relieve stresses in equipment. Available in a variety of sizes for pressure, vacuum or a combination installation.

The Garlock Packing Co.
Palmyra, N. Y.

Rope Catalog

A-14

Fiftieth Anniversary Edition of a factual catalog dealing with the characteristics of wire rope, its use, care and handling. Pleasing to the technical man, yet understandable by the layman.

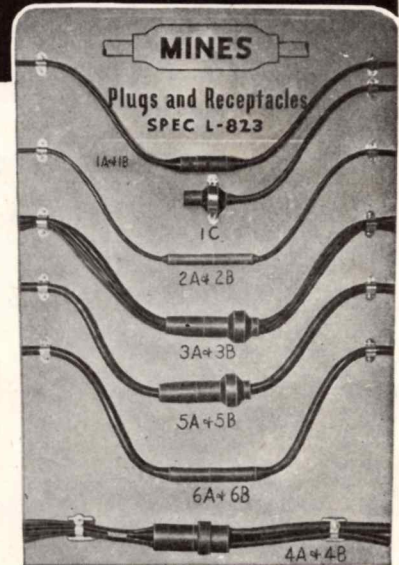
Wickwire Spencer Steel Div.
500 Fifth Ave.
New York 18, N. Y.

(Continued on following page)

Electrical Connectors for Aviation Field Lighting THAT MEET CAA SPEC L-823

Designed for... not adapted to, modern field lighting requirements MINES Molded Neoprene rubber electrical Connectors are the first choice of many of America's leading airport lighting manufacturers. Line Material Co., Westinghouse, Crouse Hines, Reverse, Fly by Night and Aviation Equipment Co., are all among our satisfied customers.

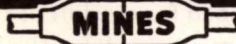
FIGURE	DESCRIPTION
1A & 1B	2E125M MALE PLUG and 2E125F FEMALE RECEPTACLE (joined)—Two conductor—15 ampere—600 volts between contacts... 1500 volts to ground.
1C	2E125F1A FEMALE RECEPTACLE—Same electrical specifications as above.
2A & 2B	1A187M MALE PLUG and 1A187F FEMALE RECEPTACLE (joined)—Single conductor—25 ampere... 1500 volts to ground.
3A & 3B	S2242 MALE PLUG and S2241 FEMALE RECEPTACLE (joined)—Five conductor, two 15 and three 6 ampere—600 volts between contacts... 1500 volts to ground.
5A & 5B	2D125M MALE PLUG and 2D125F1 FEMALE RECEPTACLE (joined)—Two conductor—20 ampere—600 volts between contacts... 1500 volts to ground.
6A & 6B	1X187M MALE PLUG and 1X187F FEMALE RECEPTACLE (joined)—Single conductor—25 ampere... 5000 volts.
4A & 4B	6-187KM2A MALE PLUG and 6-187KF1A FEMALE RECEPTACLE (joined)—Six conductor—25 ampere—600 volts between contacts... 1500 volts to ground.



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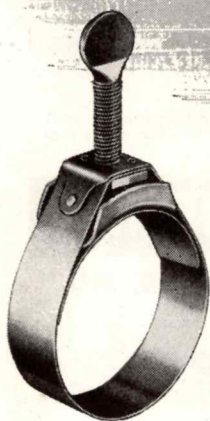


You Can Depend on

WITTEK

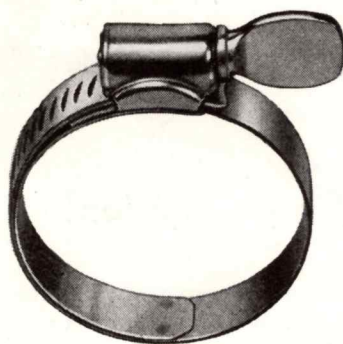
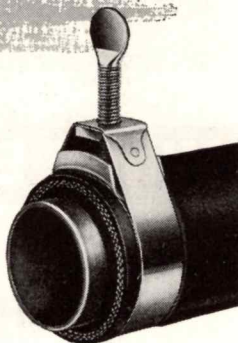
STAINLESS STEEL

Aviation HOSE CLAMPS



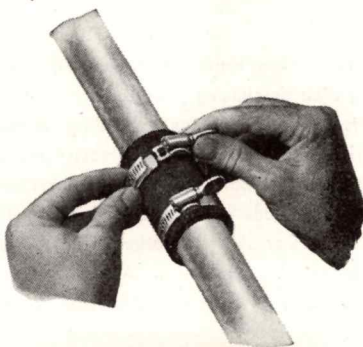
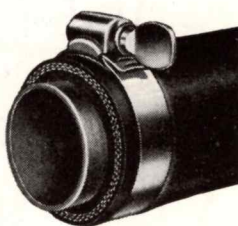
TYPE FBSS

Designed for aircraft use and recognized as the standard of the industry.



TYPE WWD

Stainless steel worm drive hose clamp. Permits installation after hose is in place.



Wittek Aviation Hose Clamps meet current AN specifications and have C.A.A. approval. Get details for any Aviation Hose Connection.

WITTEK
MANUFACTURING CO.
 4305-15 W. 24th Place, Chicago 23, Ill.



Dependability In Hose Clamps For Over A Quarter Of A Century

(Continued from preceding page)

Polystyrene Molding Powder

A-15

Booklet on *Plexene M*, a modified polystyrene for injection molding. Describes material's properties and color range; shows wide usability; and presents a helpful chapter on machining molded parts.

Rohm & Haas Co.
 Phila. 5, Pa.

Propeller Service Tools

A-16

Illustrated, 40-page catalog covering service tools and overhaul equipment for Hamilton Standard propellers. Covers each model; includes numerical parts and price list; and has an interchangeability chart.

Atlantic Airmotive
 72 Curtiss St.
 Hartford 6, Conn.

The Starrett Story

A-17

Booklet which traces the origin and growth of a company which is highly respected in its field. Profusely illustrated and dedicated "to those who know and love fine tools."

The L. S. Starrett Co.
 Athol, Mass.

Tight-Sealing Rivets

A-18

Eight informative pages in an illustrated bulletin describing the use of *Fluid-Tight* jacketed rivets and *Head-Sealing* washered rivets, developed to meet the demand for leak-proof rivets for fuel tanks, pressurized cabins, hulls and floats.

Vic Pastushin Industries, Inc.
 5651 West Century Blvd.
 Los Angeles 45, Calif.

Aircraft Hose Clamp

A-37

Bulletin on *Tru-Grip* which is claimed to provide a uniform radial compression through a flexible bridge, thumbscrew-actuated arrangement and a metal strap which conforms with the size and contour of the hose. Assembly and removal with hose in position.

Ideal Clamp Mfg. Co. Inc.
 435 Liberty Ave.
 Brooklyn 7, N. Y.

Bulletin on Fasteners

A-38

Four profusely illustrated pages with descriptions of *Quick-Lock*, *Spring-Lock* and *Lock-Nut*. Products are stressed as fasteners where speed, simplicity and security are desirable. *Spring-Lock* is a one-piece blind fastener.

Simmons Fastener Corp.
 1750 North Broadway
 Albany 1, N. Y.

Adhesives and Rivets

A-39

Catalog Section 9160 describes the range of the company's adhesives and their applications; gives classifications, service requirements and lists the different products. Illustrated 28-page *Rivnut Data Book* is packed with engineering and installation information. All the types and sizes are listed, the header tools are described and their use explained. Should be in every shop.

The B. F. Goodrich Co.
 Akron, Ohio

Silicone Note Book

A-19

Dow Corning *Silicone Notebook, Fluid Series No. 3* is a comprehensive collection of information on the properties and behavior of the DC 200 fluids.

Dow Corning Corp.
Midland, Mich.

Large Airport Lighting

A-20

Handsome, illustrated 50-page booklet which gives detailed lighting plans and wiring diagrams to assist airport executives in planning a new field or improving an old one. Covers the company's lighting and related equipment; also associated airport equipment, weather instruments to engine starters.

Westinghouse Electric Corp.
P. O. Box 868
Pittsburgh, Pa.

Aircraft Actuators

A-21

Catalog No. 4811 has 36 pages devoted to specific data covering rotary, linear and cable-drum actuators. Dimensions, performance and specifications are provided for more than 15 typical units.

Western Gear Works
Box 192
Lynwood, Calif.

High-Intensity Runway Lighting

A-22

Useful, illustrated booklet on runway lighting which can be intensified as visibility conditions demand. Are bi-directional in nature and are said to provide ample off-runway indication for circling at night below an overcast.

American Gas Accumulator Co.
Elizabeth, N.J.
sold by
General Electric Co.
Schenectady, N.Y.

Relay Catalog

A-40

Full-sized catalog with 48 pages illustrating the entire line of Advance relays, including descriptions, dimensions and contact combinations. Hermetically sealed and special purpose types shown; modifications available.

Advance Electric & Relay Co.
1260 West Second St.
Los Angeles 26, Calif.

Solder Selection Guide

A-41

Catalog No. 201 features a comprehensive guide which lists the 16 metals said to be soldered most frequently. Recommended are the best flux and solder combinations. Other information provides the physical characteristics of Alpha solders.

Alpha Metals, Inc.
363 Hudson Ave.
Brooklyn 1, N. Y.

Machine Tool Catalog

A-42

Catalog 12-D has 24 valuable pages crammed with illustrations, technical information, sizes and prices on lathes, drill presses, benches, chucks, tools and accessories. Slanted particularly to the needs of the aviation, automotive and marine service fields.

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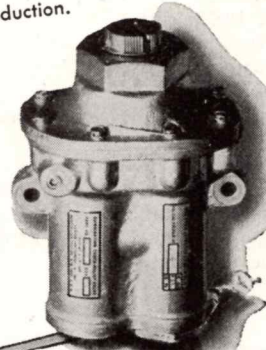
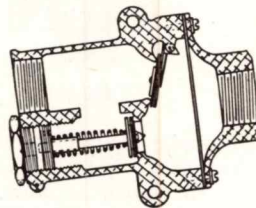
Non-metallic parts impervious to oils or aromatic fuels.

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Also available with 90° elbow and mounting flange or to your requirements.

AVAILABILITY: Currently in production.

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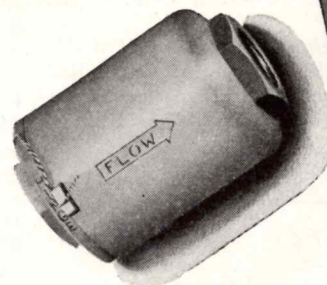
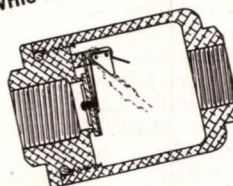
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WEIGHT: Less than 0.3 lbs. for 1/4" port valve to less than 0.7 for 1 1/4" port valve.

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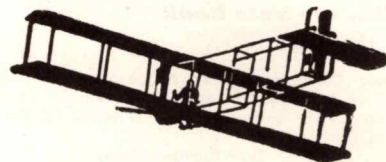
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AVIATION PATENTS

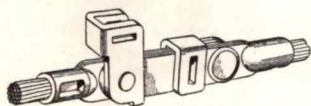


Gas Turbine Apparatus. Stewart Way, Churchill Borough, Pa., assignor to Westinghouse Electric Corp., East Pittsburgh, Pa. (2,448,561)

Duplex Four-Way Valve. Harold W. Adams, Santa Monica, and Orville A. Wheelon, Pacific Palisades, Calif., assignors to Douglas Aircraft Co., Inc., Santa Monica, Calif. (2,448,649)

Means for Controlling the Operation of Wing and Tail-Plane Elements of an Airplane. William J. Hampshire, Cygnet, Ohio. (2,448,712)

Aircraft Heating and Deicing System. Wilbur W. Reaser, Pacific Palisades, Calif., assignor to Douglas Aircraft Co., Inc., Santa Monica, Calif. (2,448,826)



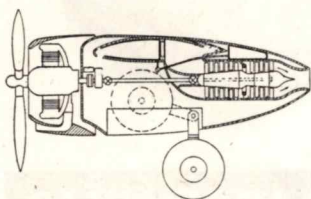
2,449,251

Separable Connector. Julian Rogoff, New Rochelle, N. Y., assignor to Burndy Engineering Co., Inc. (2,449,251) (Illustration)

Plotting Aircraft Navigation Computer. Gerard E. Tardif, Quebec, Canada (2,449,342)

Propeller Governor. Charles W. Chillson, Clifton, N. J., assignor to Curtiss-Wright Corp. (2,449,452)

Deicing System for Propeller Blades. George A. Dean, Radburn, N. J., assignor to Curtiss-Wright Corp. (2,449,457)

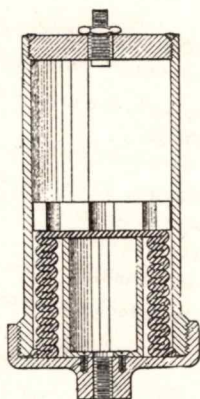


2,449,022

Fuel System for Aircraft Power Plants for Aircraft Propulsion and Boundary Layer Air Control. Edward A. Stalker, Bay City, Mich. (2,449,022) (Illustration)

Means for Facilitating the Feathering of Propellers Responsive to Yaw Control. Milo Burchan, Burbank, Calif., assignor to Lockheed Aircraft Corp., Burbank, Calif. (2,449,104)

Aircraft Cabin Pressure Control. Joseph Jerger, Ferguson, Mo., assignor to Curtiss-Wright Corp. (2,449,231)



2,450,031

Hydraulic System Accumulator. Alexandre Berger, New York, N. Y., assignor to Aircraft Hydraulics, Inc. (2,450,031)

Radio Direction Finding Means for Aviation Trainers. Karl A. Kail, Montrose, Pa., assignor to Link Aviation, Inc., Binghamton, N. Y. (2,450,240)

Aviation Trainer. Karl A. Kail, Montrose, Pa., assignor to Link Aviation Inc., (2,450,239)

Aircraft Wheel and Tire. Arthur M. Stanley, Lynn, Mass. (2,450,259)

Lighting Control System for Airports. James P. Houck, Wilkesburg N. J., assignor to Westinghouse Electric Corp., East Pittsburgh, Pa. (2,449,480)

Aircraft Flare. Joseph Albin, New York, N. Y. (2,449,540)

Aircraft Flight Stabilizing Control Unit and System. Charles L. Paulus, Dayton, Ohio. (2,449,566)

Oil Temperature Regulator. Walter H. Geddes and Phillip W. Schanke, Dayton, Ohio, assignors to United Aircraft Products, Inc., Dayton, Ohio. (2,449,696)

Electrical Connector. Charles Antony, Jr., Baldwin, and David Mannheimer, Hempstead, N. Y., assignors to the Sperry Corp. (2,448,509)

Wind Tunnel Balance. Herbert M. Heuver, Dayton, Ohio. (2,448,528)

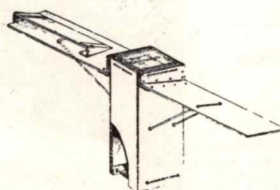
Automatic Simulated Two Pointer Glide Path for Ground Training. Carl W. Muller, Osborn, Ohio. (2,448,544)

Valve Actuating Mechanism. Herbert C. Wilkening, Dayton, Ohio, assignor to United Aircraft Products, Inc., Dayton, Ohio. (2,449,733)

Antenna System for Defining Glide Paths. Louis John Heaton-Armstrong, London, England, assignor to Standard Telephones and Cables Limited, London, England. (2,449,999)

Omnidirectional Radio Beacon. Emile Labin, New York, and Donald D. Grieg, Forest Hills, N. Y., assignors to Federal Telephone & Radio Corp., N. Y. (2,450,005)

Oil Tank and Cooler Assembly. Ralph M. Heintz, Cleveland, Ohio, assignor by mesne assignments, to Jack & Heintz Precision Ind. Inc., Cleveland, Ohio. (2,450,960)



2,450,992

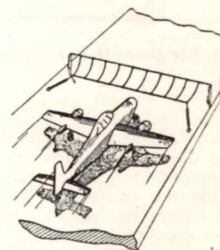
Free-Fall Aerial Container. William J. Sanderson, Madison, Wis., assignor to the United States of America as Represented by the Secretary of Agriculture. (2,450,992) (Illustration)

Reaction Jet System for Aircraft Control. William W. Williams, Buffalo, N. Y., assignor to Bell Aircraft Corp., Buffalo, N. Y. (2,451,008)

Aircraft Control Surface. William W. Williams, Buffalo and Herbert L. Bowers, Kenmore, N. Y., assignors to Bell Aircraft Corp., Buffalo, N. Y. (2,451,009)

Propeller Control Mechanism. Werner J. Blanchard and Charles S. J. MacNeil, Dayton, Ohio, assignors by mesne assignments to General Motors Corp., Detroit, Mich. (2,451,059)

Oleo Strut for Airplane Landing Gears. Milton R. Mullen, Philadelphia, Pa., assignor of one-fourth to Wm. Steel Jackson and Joseph Gray Jackson. (2,451,171)



2,450,328

Aircraft Barrier. Robert B. Cotton, Lansdowne, Pa., assignor to All American Aviation, Inc., (2,450,328) (Illustration)

Apparatus for Simulating Wind Effects in Aviation Ground Trainers. Carl J. Crane, Dayton, Ohio. (2,450,421)

Servo Units for Automatic Pilots. Percy Halpert, Hempstead, N. Y., assignor to the Sperry Corp. (2,450,427)

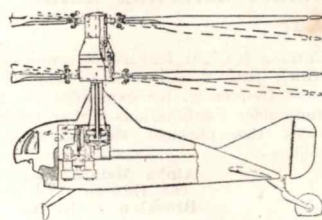
Hollow Propeller Blade. Carl J. Snyder, Detroit, Mich., (2,450,455)

Self-Locking Nut. John A. Sauer, Elizabeth, N. J., assignor to Elastic Stop Nut Corp. of America, Union, N. J. (2,450,694)

Aircraft Control. Ward W. Beman, Glendale, Calif., assignor to Lockheed Aircraft Corp. Burbank, Calif. (2,450,709)

Gas Blast Actuated Auxiliary Turbine for Gas Blast Propelled Craft. Robert H. Goddard, Annapolis, Md., Esther C. Goddard executrix of said Robert H. Goddard, deceased, assignor of one-half to the Daniel and Florence Guggenheim Foundation, New York, N. Y. (2,450,950)

Axial Flow Compressor. Karl Baumann, Mere, Knutsford, England, assignor to Metropolitan-Vickers Electrical Co., Ltd., London, England (2,450,745)



2,450,491

Helicopter. Nicholas N. Solovioff and Nelson G. Kling, Great Neck, N. Y., assignors to Airex Manufacturing Co., Inc., Long Island City, N. Y. (2,450,491) (Illustration)

Apparatus for Extinguishing Fires. Hilding V. Williamson, Chicago, Ill., assignor to Cordox Corp., Chicago, Ill. (2,450,537)

These patents, of interest to the aeronautical industry, were compiled from recent issues of the *Official Gazette* of the U. S. Patent Office. Copies of the individual patents, in pamphlet form, may be obtained from the Commissioner of Patents, Washington, D. C., at a cost of 25 cents each.



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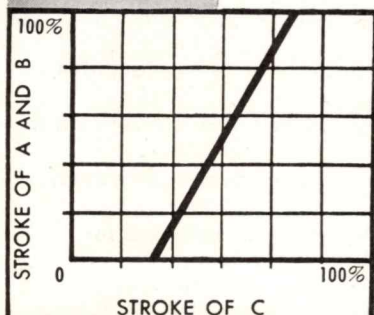
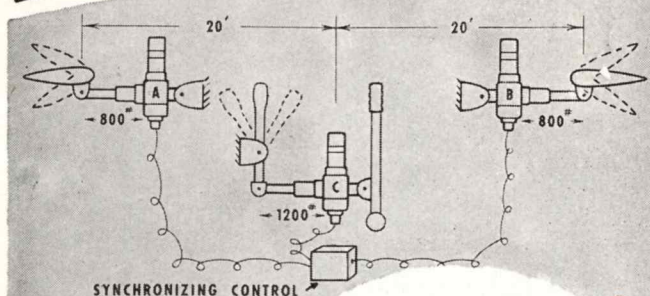
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Names in the News

Personnel changes and promotions
in aviation and allied industries



Locklin



Ehrman



Brown



Dunn

- S. R. BILLINGSLEY has been appointed sales engineer for Aeroquip Sales & Engineering, Inc.
- WILLIAM A. BLEES, formerly vice president in charge of sales for Consolidated Vultee Aircraft Corp., has been elected a vice president of Avco Manufacturing Corp. and named general sales manager of the Crosley Division.
- R. C. BROWN, formerly president of Brown-Steele Co., has been named director of sales for Foote Bros. Gear and Machine Corp.
- ARTHUR R. COLLINS, who has headed the manufacturing and engineering activities of Stewart-Warner's South Wind Division for the past 16 months, has been appointed general manager.
- DR. KARL T. COMPTON, president of Massachusetts Institute of Technology and head of the Research and Development Board, has been sworn in as a member of NACA.
- HOWARD M. DAWSON, formerly vice president and managing director of Jessop Steel International Corp., has been elected president.
- DR. JAMES R. DONNALLEY has been appointed manager of General Electric's silicone manufacturing plant at Waterford, N. Y.
- A. W. DUNN, of the public relations staff of Goodyear Tire and Rubber Co., has been transferred to the Aviation Products Division as manager of the Dayton, Ohio, office and company representative at Wright-Patterson Air Force Base.
- FRED S. EHRLMAN, general sales manager of Bowser, Inc., since 1944, has been elected to the new post of vice president and director of sales.
- E. G. FOSSUM, assistant to the senior vice president of Stewart-Warner Corp., has been appointed assistant to the president.
- ROBERT W. GALVIN, son of Paul V. Galvin, president of Motorola, Inc., has been appointed executive vice president of the company.
- OTTO THEODORE HESS, general counsel and secretary of Jack & Heintz Precision Industries, Inc., has been appointed assistant to the president.
- JAMES B. HOLLAND, II, who joined the Taylor Fibre Co. as an apprentice nine years ago, has been named sales manager.
- CHARLES H. KNAPP, JR., who has been in charge of the design and engineering department, has been made sales engineer for the Aircraft Division of Weber Showcase & Fixture Co., Inc.
- FRANK R. KOHNSTAMM has been appointed senior vice president of Jack & Heintz Precision Industries, Inc.
- PAUL LOCKLIN, formerly Pacific Coast manager for the Parker Appliance Co., has been appointed western manager of engineering service for Saval, Inc.
- WILLIAM J. MCGRAW, manager of electric to sales in the New York territory, has been made manager of the Cleveland branch of Independent Pneumatic Tool Co.
- W. C. MILES, former production manager for Glenn L. Martin Co., has been named production manager for Piasecki Helicopter Corp.

• **JOHN A. PROVEN**, formerly vice president and sales manager for Sterling Tool Products Co., has been appointed general sales manager of Porter-Cable Machine Co.

• **McMILLAN ROBINSON** has been appointed sales manager for the Metal Products Division of Koppers Co., Inc.

• **J. B. SCOTT** has been appointed quality control manager of Borg-Warner Corporation's Ingersoll Steel Division plant at Kalamazoo, Mich.

• **WALTER V. TRELEASE**, formerly head of product development of

Quaker City Metal Co., has been appointed schedules manager of Piasecki Helicopter Corp.

• **JOHN F. TURNER**, senior design engineer, has been promoted to superintendent of engineering by Weber Aircraft Division of Weber Showcase & Fixture Co., Inc.

• **STAN WILSON**, formerly general service manager of Pacific Airmotive Corp., has been appointed sales representative for Aviation Maintenance Corp.

• **R. M. ZIMMERMAN** has been named sales and engineering representative for Linear, Inc., in its midwest territory.



Alden E. Acker

Pryor Buys Hycon

Majority ownership interest in the Hycon Co. of Pasadena has been acquired by the Pryor Manufacturing Co., Mansfield, Ohio.

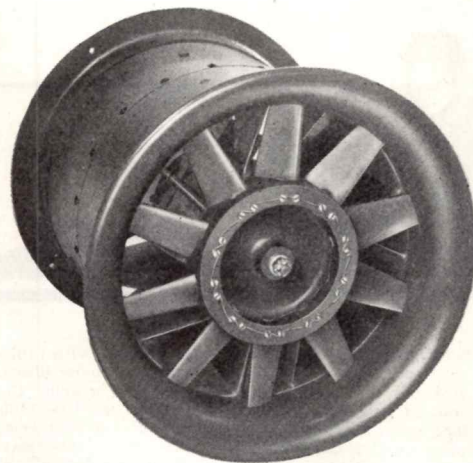
To Hycon, formerly Hydra-Control Co., has been added the engineering and management ability of Pryor's western division. The company is now tooled to handle precision work in the fields of aircraft hydraulics, special photographic equipment, and experimental ordnance units.

Active head of Hycon is Alden E. Acker, vice-president and general manager, a graduate of MIT, worker with CalTech, and more recently manager of one of the industrial plants of General Tire & Rubber.

Rheinstrom Sells Out

Charles A. Rheinstrom, who resigned as vice-president of American Airlines several years ago to enter the aviation consultant field has sold out his interests to Alvin P. Adams and Associates, Los Angeles and Washington, D. C., giving this firm a New York office.

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The Navy of Britain. By Michael Lewis. 660 pp; illus; index. \$7.50.—This book is a short, popular history, not of Britain's sea-power, but of that great institution which has implemented it—the British Navy. In six comprehensive chapters it deals with Origins, Ships, Officers, Men, Management and Action. Beautifully illustrated.

Managerial Control of Business. George T. Trundle, Jr., Editor-in-Chief. 408 pp; illus; index. \$5.—Here is a book which covers the entire field of business management written by expert practitioners in the art. The chief editor is president of the Trundle Engineering Company, and the other writers and editors are also members of the company. The first section reviews the problems that confront typical manufacturing operations. The remaining four sections cover the best ways of attacking and solving these problems, including general management, sales, manufacturing and industrial relations. Practical, down-to-earth stuff.

Precision Measurement: Methods and Formulas. By Jack Johnson. 180 pp; illus; index. \$3.—Most exceptional in point of ingenuity, practicality and arrangement. Johnson, self-styled "quality control adviser," presents a large variety of short-cuts in measuring difficult surfaces, principally concavities such as holes and grooves. Sparing in words and generous in diagrams, he makes his solutions of the typical problems seem simple and fascinating. This kind of book should go far to restore the enthusiasm for good craftsmanship which is now so conspicuously lacking in many shops.

Sources of Engineering Information. By Blanche H. Dalton. 109 pp; \$4.—A listing of bibliographies, handbooks, &c., under headings for researchers who seek clues to more detailed information. Useful as far as it goes and in the sense that to an harassed researcher any suggestion is worth following up, but is unhappily not inclusive in coverage of major engineering lines or in naming of basic materials. Compiler is in charge of the engineering library at the University of California. We hope that this work, which represents an eminently valuable idea, will be reorganized and improved in a later edition.

Aircraft Basic Science. By the Technical Development Staff of Northrup Aeronautical Institute. Charles E. Chapel, chief editor. 440 pp; illus; index. \$6.—First volume in a 3-vol. series of NAI aviation texts intended for the guidance of mechanics, inspectors, maintenance engineers and shop foremen. This particular issue, in large, handsome quarto, presents the necessary background of fundamental principles,

explained with fullness and care and with many illustrative diagrams and photographs. Coverage is general, as the title indicates, 11 chapters giving their respective considerations to such matters as Theory of Flight, Aircraft Structural Components, Aircraft Electricity, Plumbing, &c. Exceedingly useful now and definitely valuable hereafter.

New World Atlas, With Stratosphere Maps. 52 pp; illus. 50¢ paper; \$1 boards.—Importance of a good up-to-date world atlas in these rapidly changing times needs no emphasis. This is one such, with the especial merit of dependable information at low price. The "stratosphere maps" review changes in the international boundaries in very recent years. Supplementing the conventional large, clear, colored, regional maps are especial world facts and census figures, plus statistical information on each of the United Nations.

No Place to Hide. By David Bradley. 182 pp; \$2.—Bradley was a radiological monitor in the atomic-bomb experiments at Bikini. This is a report of his personal experiences and reactions. It is admirably written and makes fascinating reading. Manifestly from the title, however, Bradley's purpose was not to supply passing entertainment. An earnest desire to warn his public of the greatest danger to the world today pervades his work, which is consequently "a book with a message." In the opinion of this reviewer it is certainly a message not to be overlooked.

ASTM Standards on Plastics: Specifications, Methods of Testing, Nomenclature and Definitions. Sponsored by the ASTM Committee D-20 on Plastics. 610 pp. \$4.50 to non-members.—Amplified fourth edition of this important publication, comprising reprints from reports of the American Society for Testing Materials. Provides in convenient form the more than 100 specifications and tests developed by the Society through the intensive work of its committees on plastics and electrical insulating materials.

Tool Steel Simplified. By Frank R. Palmer and George V. Luerssen. 564 pp; illus; tables; index. \$2.—Revised edition of a work first published in 1937 and reprinted 15 times thereafter. The authors are respectively president and chief metallurgist of the Carpenter Steel Co., Reading, Pa. The theme is how to make better and less expensive tools and dies, and the book certainly offers an extraordinary profusion of ways and means to that end. In the text the gamut is run from choice of materials to the training of skilled workers to be entrusted with the end products. A feature is the new alphabetical "Tool Steel Selector Section," which gives the requirements for each sort of tool and the corresponding type of steel to be employed for it.

Flying Health. By M. Martyn Kafka. 248 pp; illus; index. \$2.—One of the best books of its sort. A copy should be permanently and conveniently in the kit of every airman. Apart from its general recommendations for personal health routines, it contains specific directions for meeting such unexpected encounters as snakebites, attacks of poisonous insects and contacts with dread diseases in countries off the beaten track. The index is especially well made for those who may wish to consult the book quickly in an emergency.

Toward an Unknown Station. By Allan Lyon. 289 pp; \$3.—A running narration of the daily life of an ordinary GI in World War II, European Theatre, that might well be also the story of each and every one. Vivid and human in the telling, its perusal leaves an indelible impression of "having been there" and of never wanting to be there again. Not a novel, but a succession of admirably done word pictures.

Private Pilot Examination and Instruction Covering New Civil Air Regulations. By Charles A. Zweng. 64 pp; \$1.—A new, revised edition of a well-known guide to the CAA Private Pilot Rating. Contents embrace applicable CAA regulations, air traffic rules, general operation rules, pilot-certificate forms and 100 "multiple choice" questions and answers.

Engineering Thermodynamics: Theory and Applications. By Jesse Seymour Doolittle and Alexander Hamilton Zerk. 429 pp; illus; tables; index. \$5.—So closely packed with relevant information that it seems almost encyclopaedic in the field. The writers, professors of engineering at, respectively, North Carolina State College and Pennsylvania State College, planned the book to cover a year's work in thermodynamics and stress the fact that is takes up but one item at a time so as not to confuse the student.

A Simplified Introduction to High Speed Flight. By Thomas F. Weldon. 42 pp; illus. 75¢.—A booklet of definitions, written with the laudable purpose of reducing "some of the more salient topics of modern aerodynamics into simple everyday English." The author realizes that aim admirably, and at the same time conveys, by means of well-chosen words and pictures, a clear idea of what goes on in the world of jet propulsion. Useful and valuable.

Weather Forecasting. By S. W. Pack. 192 pp; illus codes; index. \$6.—Author is an instructor commander in the British Navy. Done with evident mastery of the subject in easily followed phraseology and with ample coverage of the ways and means. Restores respect for the weather forecaster at a time when, in this country at least, meteorologists have fallen into considerable disrepute. A valuable, solid contribution to the already voluminous literature on this racy specialty.

Radio Engineering, Vol. I. By E. K. Sandeman. 775 pp; illus; index. \$6.50.—A textbook of fundamentals by a well-known British radio engineer. Includes basic information on many problems frequently neglected in other works of the kind, and treats all of it with simplicity and an irresistible appeal to common sense. By any odds one of the most thorough and practical manuals to reach this reviewer's desk.

Crucibles: The Story of Chemistry. By Bernard Jaffe. 481 pp; bibliography; index. \$3.95.—Revised edition of a popular history originally published in 1930, bringing the narrative abreast of late advances in nuclear fission. A worthwhile contribution to the extensive literature which is designed to bring the gigantic fields of human endeavor severally into comfortable focus.

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(Continued from page 28)

by economic controls also must be voted.

Forrestal's insistence that an increase in any of the three Services be met with balancing increases in the other two is a further complication. Officials will be on guard against a boost for air power alone, as in the 70-group appropriation which Congress voted almost unanimously against strong executive opposition. Gag rule once more is being sternly applied to all official utterances on the true needs of the Services.

Thus, it is hard to tell just what the Air Forces really require. We merely know that the Congressional Aviation Policy Board report, looking ahead to the depletion of the planes left from the war, recommended a rising scale of appropriations to replace with modern planes in five years. Otherwise the total number of planes on hand will diminish. Aircraft and missile research, development of new transport planes, and other urgent needs likewise will be slowed with the result that we will not be much readier for emergency by July 1950 than we are today—unless more funds are voted.

Much will depend on Russia's actions. Last year new scares about aggression, more than the arguments of our own airmen, pushed through the extra contract authorizations. Conditions now are worse, but we tend to become used to a state of affairs as in Berlin or in China.

- Meanwhile, there is still confusion in the newspaper versions, if not among officials themselves, as to the whole theory of warfare.

In recent maneuvers off Newfoundland, Admirals admitted that eight schnorkel-type submarines could have defeated the "invasion" under actual combat conditions and that a larger fleet of subs could sweep our merchant marine off the seas. This looked like bad news for the Navy's carrier-task force theory. But naval experts pointed out that there are now under development anti-submarine devices which are expected to overcome the schnorkel-sub menace.

An Air Force solution to this will be the use of "strategic air transport" in an extended air-lift operation to supply overseas bases.

More is heard of "cracking heads together" to make unification work. It sounds like the answer to a lot of good people who don't seem to remember that crack-down—which stills honest opinion—was the same sort of thing that happened to Billy Mitchell and the other champions of air power.

Some added powers for the Defense Secretary may be considered. Otherwise it is not expected that the Hoover Commission findings will make any very drastic changes as to military or civil aviation.

- On the civil side, the continued financial distress of the airlines will reopen the old debate around the obsolete Civil Aeronautics Act. The airlines will fight for regulation of contract carriers and other measures that have been batted around.

The independents and the sea-air advocates will be fighting again for separation of air-mail pay from subsidy and otherwise

in reverse of the airline position. Result quite possibly will be another stalemate.

- For the fixed-base operators, resumed efforts toward a youth-training program do not give hope of early relief. The Air Force has republished the wartime regulations as to training contracts, but this was merely a routine step in line with the unification law.

Meanwhile the Veterans Administration approved about half of more than 20,000 GI flight applications received since the new law took effect in July. This compares with a total of new student pilots about 20,000 per month in prior years.

Neither CAA nor the industry has shown any effort toward aggressive action to prevent the closing of hundreds of airports which will result from this situation.

FUTURE OF THE PROP

(Continued from page 19)

was relatively unimportant in the past, when propeller sizes were smaller and air speeds were lower, has reached the proportions of being the governing factor in propeller design. However, methods have been developed for predicting analytically the magnitude of *IP* vibration, and propeller manufacturers, at the penalty of some increase in weight, are increasing the structural strength of the blades to take care of this excitation.

With propeller requirements for the newer piston engines met, the industry plunged into a second and even more demanding program. Although the piston engine is far from being eliminated from the transport and bombardment field, the gas turbine will unquestionably be used more and more. Increasing emphasis is being placed, in military and commercial circles in this country and abroad, on the advantages of combining the jet engine and the propeller.

The Developing Turboprop

The turboprop puts its energy into turning a propeller through a reduction-gear system, instead of producing its thrust by ejecting a jet stream. Any improvements in the thermal efficiency of the gas turbine will improve the turboprop at least equally. The turboprop possesses the light weight and high power of the turbine while retaining the propeller's superior efficiency, greater maneuverability and low-speed control for landings and takeoffs.

Development of the turboprop is proceeding rapidly in this country and in Great Britain, where a turboprop-powered airliner has already been built. Here, development of propeller types for installation on turbine engines has already indicated the general form of the future propeller.

Because of the extremely high powers possible with turbine engines, it appears that propellers will be heavier and larger. However, it seems that the ratio of about one-quarter pound of propeller weight per engine horsepower, which pertains to today's reciprocating engines, will be maintained with the higher horsepower turbine types. Analytical investigations have shown

further that for medium and long-range operation the propeller's weight would be only a fraction of the added weight of fuel required by the turbojet.

For example, in a 500-mph aircraft of the attack-bomber class having a range between 2600 and 2700 miles, the analyses showed that a jet-propelled version would require 17,000 lbs of fuel. This fuel load can be cut in half by the application of the more-efficient propeller and reduction-gear system to the powerplant. The resulting increase in powerplant weight would total only 1350 lbs, of which 750 lbs would be for the propeller and the remainder for the gearing and other powerplant changes. This would result in a net increase in the pay load of approximately 7500 lbs. For greater ranges involving substantially larger fuel load requirements, the increase in powerplant weight due to the propeller installation would be practically negligible as compared with the saving in fuel weight made possible by the propeller's use.

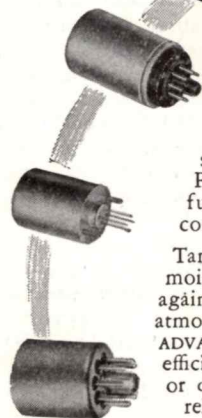
As powers increase beyond the 10,000-hp mark, there will be an increased impetus for the further development of multi-bladed, dual-rotation propellers in order to maintain reasonable diameters. The mechanism for dual-rotation, high-horsepower propellers will be complex, requiring a great deal of time and effort to develop; but there is every reason to believe it can and will be done. Present development programs are concentrated, for example, on perfecting a single lever-control system to coordinate propeller and turbine controls. This will result actually in a much simplified method of operation from the pilot's standpoint.

In this connection, the field of electronics is being thoroughly explored as evaluation of its usefulness for the new control system continues. In order to match the operational characteristics of the turbine, the propeller's response characteristics have been developed to make available a rate of pitch change of 30 degrees per second. This compares with the four-or-five-degrees-a-second rate previously available for reciprocating engines. An accompanying development has been the provision of a compensating device to eliminate the tendency for "hunting" induced by the dynamic characteristics of the turbine and this higher rate of propeller-pitch change.

The history of flight speeds since the days of the Wright brothers has followed a definite pattern. Even with the accelerating force of two world wars, transports and other load-carrying, long-range aircraft have held to a mean annual increase in speed of approximately 14 mph. Although fighters and fast light bombers may range far beyond this scale, the points of range, fuel consumption and economy of design, development, construction, operation and maintenance must be the determining factors in the consideration of long-range, non-expendable transport and bombardment aircraft.

A number of conclusions concerning the future of aircraft propellers can be drawn. First, even if considered from the longest view, cargo, transport and long-range bombardment aircraft can operate economically only at speeds below that of sound.

Second, progress made in the development of high-speed propellers proves their greater efficiency over any other form of

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propulsion at speeds up to that of sound. Indications are that this superiority, as the result of continued research and development, may be continued through the sonic range and into the lower supersonic speeds.

Third, the major fields of jet propulsion appear confined to those of supersonic interceptor fighters and light, short-range bombing, where economy and efficiency are secondary to speed.

Fourth, in the transport of cargo and passengers and in long-range bombardment, the propeller, whether installed on reciprocating or gas-turbine engines, will continue as the primary propulsion means.

PRESSURE MOLDINGS*(Continued from page 47)*

erties were considerably higher than the minimum properties called for in aluminum-alloy die castings. This fact, coupled with a stipulation of the type of casting machine required, indicated to commercial die casters that it was the belief of those who authored the specification that it would be necessary to employ cold-chamber die-casting machines as opposed to warm-chamber machines.

During the war, pressure moldings were specified wherever the casting was to be subjected to stress in service. Rigid inspection was justified, as human life was at stake. Radiographic

inspection of millions of pressure moldings revealed one important fact: die castings could be made sound and free of internal defects, provided care was exercised in their preparation!

When pressure moldings made their official appearance, the average die caster tolerated them as a necessary war evil. They were looked upon as a bastard type of casting doomed to ultimate commercial failure. True, they possessed superior mechanical properties. Yet they cost so much to produce because their production called for special, expensive, high-pressure machinery, carefully controlled foundry technique, thorough radiographic inspection, ingenious die construction and design, and rigorously controlled casting procedure! How could this expensive casting possibly hope to compete against the ordinary die casting? But pressure moldings have survived and today give all evidence of becoming a universally accepted type.

The No. 11347 specification was a courageous attempt. It was a great stride forward. At the time it was issued it seemed to many die casters to ask for the impossible. Yet today the mechanical properties it specified are inferior to the quality of modern pressure moldings.

This year is witness to a new chal-

lenge: Pressure moldings now compete successfully with certain grades of aluminum-alloy forgings, with heat-treated sand and permanent-mold castings, and with cast-alloy iron and malleable iron!

PACKARD FACILITIES*(Continued from page 33)*

The air-refrigeration equipment can drive the temperature down to 70° below zero (F). To give a layman's idea of its size, this equipment could produce over 250 tons of ice daily.

Electronics research has provided many a shortcut. For example, electrical circuits are used to detect causes of turbine-blade vibration. Through electronics, Packard engineers have been able to solve problems in two weeks that might have taken a year otherwise.

In the turbine wheel-test laboratory, cold air is sucked through each wheel, spinning it up to 11,500 rpm. Cold air is used for these tests because hot air requires more driving power.

The stands on which engines are anchored for test runs are so sensitive that the weight of a quarter will affect the instruments. Frequently, so many instruments are involved in a single test that they are photographed to save

time otherwise required to write down each individual reading.

Packard has been a pioneer in the aircraft-engine field, having begun its efforts in 1914, following through with the World War I *Liberty* engine, and some 56,000 Packard-modified versions of the famous Rolls-Royce *Merlin* liquid-cooled V-engine during World War II. The company will continue to exert all possible efforts to keep the American flag flying in the aircraft gas-turbine field.

MOLYBDENUM

(Continued from page 31)

Even at much higher temperatures, short-time protection was attained—sufficient for the molybdenum Pitot tubes built into the nozzle end of ram-jet engines used for pilotless aircraft. These tubes, which are subjected to a gas temperature of about 3000° F, are expendable and need not last over five minutes. A simulated service test of a ceramic-coated tube indicated a life in excess of 45 minutes. In the photo, the 10-in tube at left is uncoated, while that at right has been ceramic coated except for one inch at the end not heated in service.

The need remains for coatings which will have greater durability and which can therefore be used for high-temperature applications where longer service life is required.

THE "ZERO READER"

(Continued from page 59)

To provide additional anticipation and to facilitate the approach to the localizer beam during turbulent air, a bank-attitude signal is introduced into the *Zero Reader* as obtained from a vertical gyro. Thus there is an accurate, composite roll and directional-response indication on the vertical line to bring the aircraft on course in its proper turn attitude.

The off-position of the aircraft away from the localizer course is a displacement error. The magnitude of the heading change toward the beam is a measure of the rate at which the displacement error is decreasing—a first derivative of the displacement error. The magnitude of the angle of bank is a measure of the rate at which the compass heading changes—which is a second derivative.

The indication therefore is based on the servo-mechanism formula: Displacement plus First Derivative plus Second Derivative. Proper constants were selected through hundreds of hours of experimental flying and ILS approaches under the hood.

The vertical gyro also measures pitch-attitude changes necessary to regain the glide path when the aircraft is displaced. Zeroing the horizontal pointer will return the plane smoothly to the glide path with no overshooting or oscillation while stabilizing on the course. Pitch-attitude change is a direct

measure of the rate-of-change of glide-path displacement error.

In addition to the two-element indicator, there is a heading selector. A knob controls the course setter which internally positions the selector selsyn to the magnetic heading. The *Zero Reader* switch provides for turning the radio track on and off and for adding the glide-path signal in the "Approach" position. Selection of the radio track for VHF range, omnirange or localizer is accomplished by tuning the navigation receiver.

An amplifier is the heart of the system. The full component is one-half ATR rack size. It provides the mixing circuits, bank limiter, vertical gyro and altitude control.

Cross-country instrument flying can be done with the *Zero Reader*. The selector is adjusted to the desired heading. The pointer

will read zero as long as this heading is maintained; any slight deviation will be immediately apparent. Drift angle, due to a cross-wind, may be read off the heading selector.

The altitude-control switch can be turned on at the desired altitude and great altitude accuracy obtained during cruising or turns by keeping the horizontal pointer zeroed.

Manual ILS approaches with the Sperry *Zero Reader* are so accurate that they can be improved only by the highest type of stabilization, as provided by an autopilot. The unit can be regarded as manual standby equipment for automatic-approach equipment. And no periodic practice is required for the pilot to keep his hand in.

After flying cross-country radio ranges to destination, the pilot can switch the *Zero*



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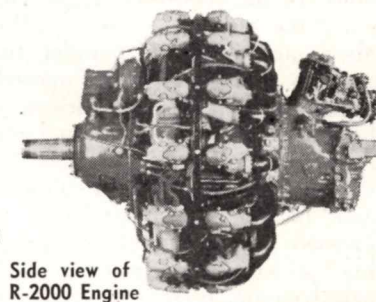
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Reader on the localizer and glide path for an ILS landing. In the landing approach he utilizes the same instrument without human transition. The ease of piloting the aircraft under these conditions gives the pilot plenty of time to monitor his conventional instruments and controls, even in the final stages of approach. In fact, here the pilot is considered the "servo" in an otherwise automatic system.

Sperry engineers maintain that the Zero Reader will practically eliminate missed ILS approaches, which are all too frequent now. It is designed to ease pilot strain and reduce the need for periodic tedious practice on instrument-landing systems. The unit enables pilots with little or no ILS experience to make good approaches on the beam.

The Zero Reader is not designed to replace any existing flight instruments. Its worth is looked for in aircraft not equipped with autopilots and as standby equipment

for automatic-approach control. If properly employed, it may greatly reduce pilot training requirements on instrument approaches, for an even greater degree of skill, and permit lower weather minimums.

The Air Transport Association has completed an extensive flight-evaluation program with a Zero Reader installed in its DC-3 Beta. Pilots of member airlines and the CAA gave it a fine reception, and one owner of a large executive plane wants one installed just as soon as it can be made available.

Yes, the cost of an installation will probably approximate \$4000 if enough interest is shown to warrant production. The cost involved in missed bad-weather approaches might well pay for one in short order aboard one of the large transports.

A word of warning. The Zero Reader bug bites hard. Anyone afflicted by its charm is almost sure to succumb. Take it from one who has had the experience!

PRESSURIZED CABIN FRAME ANALYSIS

(Continued from page 63)

justed to do so) when the elastic equations are written in foregoing order.

This is a useful theorem, generally applicable to this type of strain-energy analysis, and may be utilized either appreciably to shorten the tabular work of obtaining values of the numerical coefficients for the elastic equations, or as a partial check on the numerical accuracy of the tabular strip-integration process.

Having thus obtained the elastic equations for the several redundants, a simultaneous solution thereof yields the numerical values of X_V (if any), and X_N , and X_M , from which all other moments, shears, and axial loads within the frame may be determined by statical methods.

In recapitulation, it should be stressed that in any case, before the redundant forces and moment are located and the elastic (energy derivatives) computations are begun, the entire frame as a free body should be put into equilibrium externally by satisfaction of all external statical equations. In the relatively simple case of *fig. 1* the assumptions of a uniformly distributed pressure, parallel frames, and no additional superimposed external forces or redundancies were sufficient to satisfy these external equilibrium requirements.

However, this is not always the case in less simple problems where pressure (sum of internal supercharging pressure and external variable aerodynamic pressure) may not be even approximately uniformly distributed, or where cutouts require the addition of "external" redundants to the frame structure. These points are demonstrated by the elementary problems of *figs. 2* and *3*.

The ring structure of *fig. 2* is similar to that of *fig. 1*, except that the pressure distribution (pressure $\times$ frame spacing) is no longer uniform but is greater (outward) at the top. If such pressure distribution is symmetrical about the centerline of the aircraft and the outer profile of the frame itself is symmetrical, the resultant upward pressure force, corresponding with the lifting force on a wing rib, lies in the plane of symmetry and in this case may be assumed to be reacted at each side skin by a non-uniform shear flow, q . This shear flow, however, is often assumed to be uniform for analysis purposes if so justified by the arrangement of stringers and longerons.

A Different Problem

Fig. 3, on the other hand, represents a somewhat different problem, involving a symmetrical frame with a symmetrical skin cutout (entrance hatch, for instance), located on the centerline. Although this horseshoe-shaped structure is not a complete ring, it is still statically indeterminate and may be considered for analysis purposes to have "external" redundants as shown. Here again statical relations require side skin shear reactions, q (#/in.), as indicated. However, in this case q is a statical function of the redundant forces X_A and X_B , as well as the numerically constant pressure loads.

Returning to *fig. 1* and the relations pertaining thereto, let us examine further some of the details of this "barrel stave" analysis. *Eq. (6)*, *(7)*, and *(8)*, are a mathematical summary of what must be done to obtain the necessary simultaneous elastic equations. As already noted, the moment M rep-

resents total bending moment at any point on the nominal neutral axis of the frame and is a function of the constant applied loads (in this case, pressure), the redundant forces and moment (independent variables), and location (*i.e.*, coordinates). Thus, the moment at any point (say, the center of any Δs increment) of *fig. 1* is:

$$M = X_V y - X_N z + X_M + M_P$$

where M_P is the moment due to pressure acting on the free-body cantilever, and the moment is taken as positive when it puts the outside chord of the frame into compression. For uniform internal pressure (p) and frame spacing (l), $M_P = plab$, where

a = moment arm of resultant pressure force, P , as shown;
 b = length of effective "pressure line" (distance AB , *fig. 1*).

Likewise, at any such point on the neutral axis, the corresponding moment partial derivatives are:

$$\frac{\partial M}{\partial X_V} = +y$$

$$\frac{\partial M}{\partial X_N} = -z$$

$$\frac{\partial M}{\partial X_M} = +1$$

For the coordinate sign convention of *fig. 1*, the resulting elastic equations may be written as follows:

$$\begin{aligned} E \frac{\partial W}{\partial X_V} &= \sum_F y (X_V y - X_N z \\ &\quad + X_M + plab) \frac{\Delta S}{I} = 0 \quad (6b) \\ E \frac{\partial W}{\partial X_N} &= - \sum_F z (X_V y - X_N z \\ &\quad + X_M + plab) \frac{\Delta S}{I} = 0 \quad (7b) \\ E \frac{\partial W}{\partial X_M} &= \sum_F (X_V y - X_N z \\ &\quad + X_M + plab) \frac{\Delta S}{I} = 0 \quad (8b) \end{aligned}$$

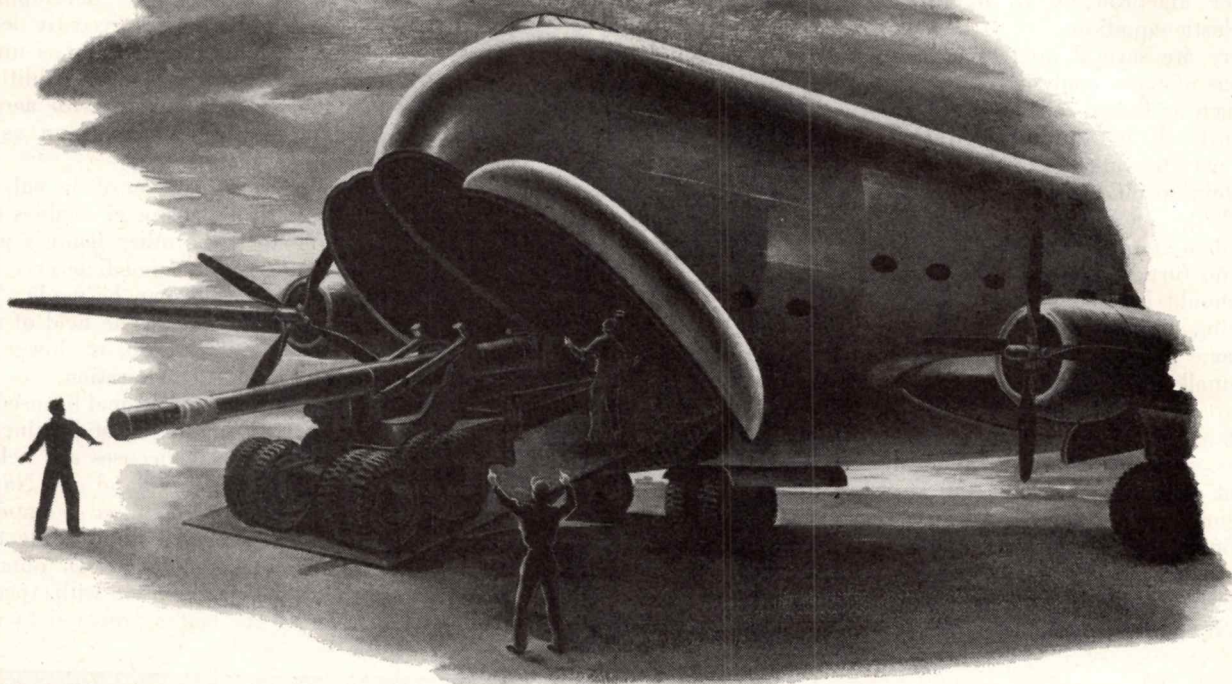
The possibilities of utilizing tabular strip-integration for expressing these equations numerically should be obvious, and it is felt that the tabular details may well be left to the discretion of the individual engineer. It might be pointed out again, however, that for the usual case of symmetrical loading and structure, *eq. (6b)* drops out of the picture entirely, and the X_V terms are eliminated from *eq. (7b)* and *(8b)*, leaving only two redundants for consideration.

It should be noted further that for such symmetrical conditions it is necessary to strip-integrate *one side only* of the frame to obtain the elastic equations, as the other side gives identical values of final coefficients and constants, thus merely doubling both elastic equations.

For conditions in which symmetry

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of loading and structure does not exist, a summation of both sides of the frame is necessary to obtain the final simultaneous equations. However, instead of integrating completely around the frame in either a continuous counter-clockwise or clockwise direction, it usually is simpler to integrate each half of the frame separately, beginning at the "cut" each time and adding the corresponding results of the two halves together algebraically to obtain the final elastic equations.

There are several interesting modifications of these analytical fundamentals, such as the so-called "elastic center" method, for instance (Ref. 4), which may be valuable to the engineer in certain specific instances. However, it is felt that such "short-cuts" are well covered in standard textbooks and require no further consideration here.

It should be noted that, as in the foregoing discussion, all deflections of the frame structure are assumed to be very small and secondary flexural effects are assumed negligible; the general law of superposition of loads, stresses, and deflections is applicable without reservations. Thus, the stress distributions for other frame-loading conditions which do not depend upon internal pressure may be determined by separate analyses and later superimposed upon the effects of cabin pres-

surization. In some such cases, it may be desirable to set up "unit" analyses to cover a large selection of such loading conditions.

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TEETH FOR JETS

(Continued from page 41)

and J-47 units, Westinghouse's J-30 and J-34 and Pratt & Whitney's J-42. All this was far from easy. The personnel concerned sweated prodigiously in the process.

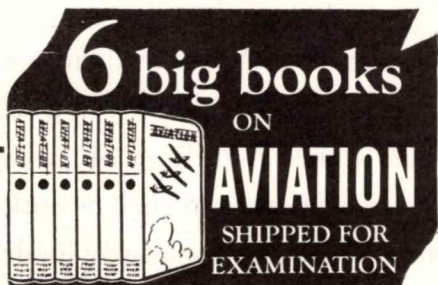
The problem of casting hollow nozzle blades in various high-temperature alloys, in itself requiring a tremendous improvement in casting techniques, presented many mechanical difficulties. This program is still in its infancy yet has been successful enough to allow a

number of current engines to utilize this type of blading. The prime reason for the use of hollow nozzle blading is one of weight reduction. However, there is the possibility of air cooling.

Current orders for jet engines far exceed the dreams of even the most optimistic just a few years back, and plans for the future indicate that a greater capacity for all methods of producing turbine blading will be required. In view of these developments Austenal Laboratories recently leased a new plant in Chicago and is undertaking the construction of additional facilities in New Jersey, with acreage available for quick expansion as the occasion demands.

The close association of the sub-contractor with his customer enables each to understand the other fellow's problems. As a result, immediate necessary changes in design can be made. This is particularly true in the field of casting where tooling costs are lower and more adaptable to alteration.

During the war Austenal licensed the British Air Commission and trained its personnel. Today licenses are held in England by De Havilland and Napier. Representatives of these companies have been trained in the casting technique and with information obtained through their association with Austenal personnel are better prepared to meet



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the problems that turbine blades frequently present.

Licenses for the *Microcast* process have been arranged also for France, Holland, Belgium, Luxemburg, Sweden, Switzerland, Italy and Spain and active production by this method is in progress. *Microcasting* has literally put teeth into the aircraft industry.

PROP PITCH REVERSAL

(Continued from page 24)

the standard angle for ground reversal is 18°. This should be around 8° for in-flight reversing.

Repeated tests of reversing in flight have brought rates of descent which have averaged 8000 *fpm*; a rate in excess of 10,000 *fpm* has been attained. All this in an aircraft which under normal emergency procedures has a maximum rate of descent around 4000 *fpm*.

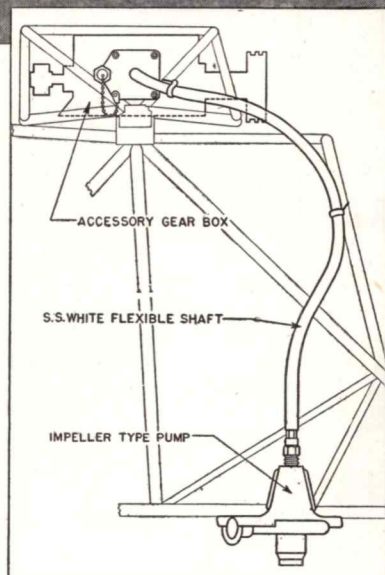
During a demonstration to officials of the military, airlines, Government and manufacturers, Herb Fisher and his crew started their reversed-prop descent five miles from the airport at 15,000 *ft*. They stepped out of the plane on the airport apron less than four minutes later, during which time the C-54 had been brought down to 1000 *ft*, levelled off and the propeller pitch changed to forward thrust, the plane flown over the field and brought in on a partial downwind landing, and the landing roll rapidly decelerated by again applying reverse thrust through the propellers.

The angle of descent was held at a steady 40° and the forward speed of the transport was 190 *mph*. Spectators on the ground compared the performance of the test aircraft with that of a regular airline DC-4 which flew alongside when the emergency letdown was begun at 15,000 *ft*. The airline transport, using its maximum-rate-of-descent procedure, showed a high forward speed, smaller angle of descent and had to circle the airport once until sufficient altitude was lost to make a landing. The airliner required twice as much time to arrive back on the apron. The Curtiss-Wright test plane trailed a stream of white smoke so that it could be identified readily during flight.

Fisher emphasizes that pilots should not be encouraged to try in-flight reversing. Experiments so far still leave many questions unanswered. There should be governor control for reverse thrust as well as forward thrust and the blades will have to be modified to absorb the added stresses. Engines, and engine mounts too, may require modifications to stand up under repeated changes of direction of thrust. Before certification for regular in-flight blade-pitch reversal, the entire structure of an aircraft would have to undergo a thorough design analysis and testing program.

The "vision boys" already see a practical everyday use of rapid letdown with the reversed-pitch method. They believe airline operating efficiency can be improved by permitting high-altitude planes to fly practically the entire course at their most efficient altitude and descend rapidly when only a short distance from their destination.

S.S. WHITE FLEXIBLE SHAFTS ARE A PERFECT "FIT" FOR MANY AIRCRAFT JOBS



In the crop-dusting helicopter (above) an S.S.White flexible shaft takes power from the accessory gear box to drive an impeller-type pump with a 50 psi head.

Illustrations, courtesy of Bell Aircraft Corp.

Providing satisfactory drives or controls for various aircraft parts and accessories is not always as tough a problem as it would seem.

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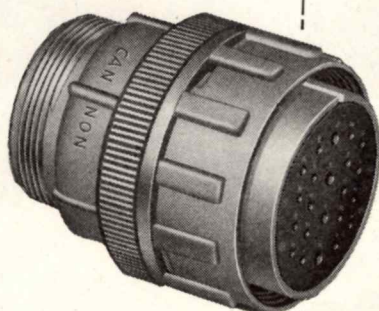
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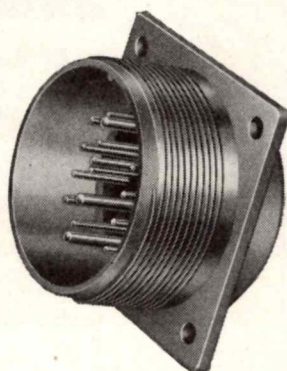
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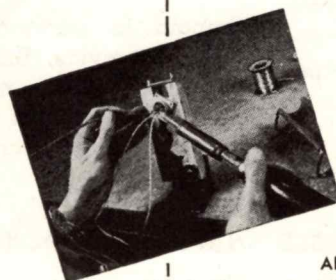
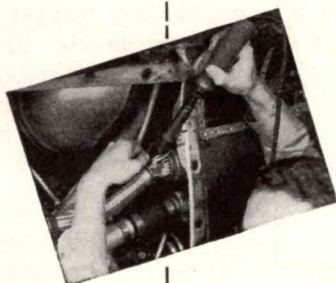


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NON-FLAMMABLE FLUIDS

(Continued from page 56)

perimentation and the expenditure of hundreds of thousands of dollars before they became realities. Numerous formulas and fluids were studied, tested and weeded out in that time.

They have one thing in common. Their use necessitates a type of packing material and sealant different from the compositions now in use in aircraft. Electric wiring also may have to be protected against hydraulic-system leaks to prevent softening of the insulation. No special precautions need be followed during handling or storing.

AVIGATION AIDS

(Continued from page 17)

for the personal plane and the small, space-conscious fighter plane. Industry, CAA and the military are developing such equipment.

Approach Lights.—During periods of low visibility, when the pilot brings his plane to earth guided by ILS or GCA, there still remains the completion of his landing by a visual touchdown after he breaks through the overcast. Approach lights extending several thousand feet out from the instrument runway help him sense his position earlier and make the transition from instrument to visual flight much easier. This is true under all poor visibility conditions, day or night.

The air navigation and traffic control problem will be resolved finally by a solution which establishes one uniform, integrated system, practical for civil and military operators alike. It is estimated that the complete program will cost \$1,100,000,000. All-weather flight for everybody is surely worth every cent of it.

WEIGHT & BALANCE

(Continued from page 44)

pose. A carpenter's level can be placed at the specified leveling point and the tail wheel blocked up until the bubble is at the center of the level. This is leveling horizontally. If extreme accuracy is desired, the airplane may be leveled laterally as well. However, this is not absolutely necessary.

The scale readings are then taken (fig. 5). The sum of the scale readings, minus the tare weight, equals the weight of the airplane. The true empty weight will be the airplane weight less the weight of any oil in the tanks.

The empty weight and empty-weight cg must be found before the weight and balance for the loaded aircraft can be computed. Seldom is an aircraft weighed when it is

(Continued on page 94)

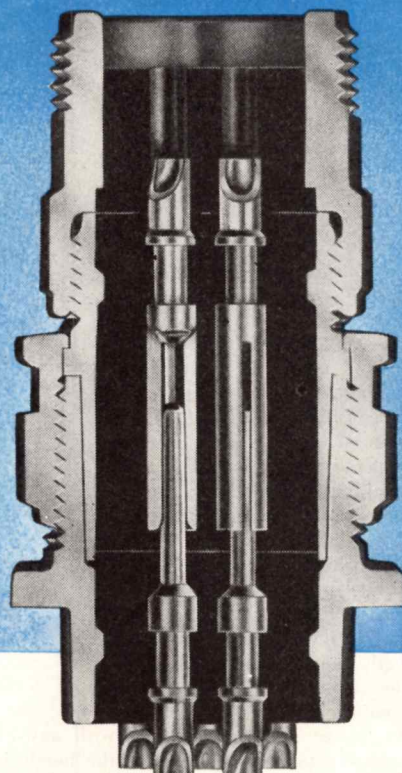
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(Continued from page 92)

loaded, for the *cg* determined under such conditions would be accurate only when the aircraft is loaded in this manner. The empty weight and empty-weight *cg* provide a basic set of figures not subject to change. The *cg* for any loaded condition may then be found by computation.

Once the weights and arms are known, the problem is one of finding the *cg* (or point of balance) of the total weight of the airplane. Fig. 6 supplies a simple illustration.

In determining the *cg*, it is not always true that the wheels are located aft of the datum line. The method of solving the problems remains the same, however, except that the measurements of the arms now become plus (+) and minus (-) arms, the given sign indicating direction of location from the datum line. In all problems involving signs, the rules of mathematics applying to signs must be rigidly followed.

In some cases, the pertinent Aircraft Specifications state the *cg* location in relation to the *M.A.C.* The basic method of finding the *cg* remains the same except that the location is measured as a percentage of the *M.A.C.*

As the chord of an untapered wing, or airfoil, is a straight line measured from the leading to the trailing edge, the chord of such a wing can be considered as the *M.A.C.* for practical purposes of weight and balance. In the case of a tapered wing, each rib has a different chord, making it necessary to consider the chord of the wing as a whole to get an average of all the chords.

The process of determining the *M.A.C.* of a wing becomes quite involved if extreme accuracy is necessary. However, when the *M.A.C.* is not known, it may be approximated closely enough for practical purposes. In the case of the non-tapered monoplane wing, the *M.A.C.* may be assumed to be the same as the actual chord and the leading edge of the wing may be taken as the leading edge of the *M.A.C.* In the case of a biplane with a rectangular or moderately staggered arrangement of non-tapered wings, the *M.A.C.* is determined as shown in fig. 7.

In the case of highly tapered wings, wings with considerable sweepback, or other unusual arrangements, the manufacturer should be contacted for the necessary information, or calculations in accordance with *Civil Aeronautics Manual 04* should be submitted to the local CAA inspector.

Rarely will it be necessary to calculate the *M.A.C.* since this information is usually supplied in the Aircraft Specifications for the airplane in question.

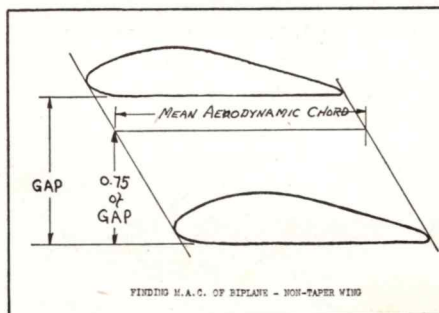


Figure 7

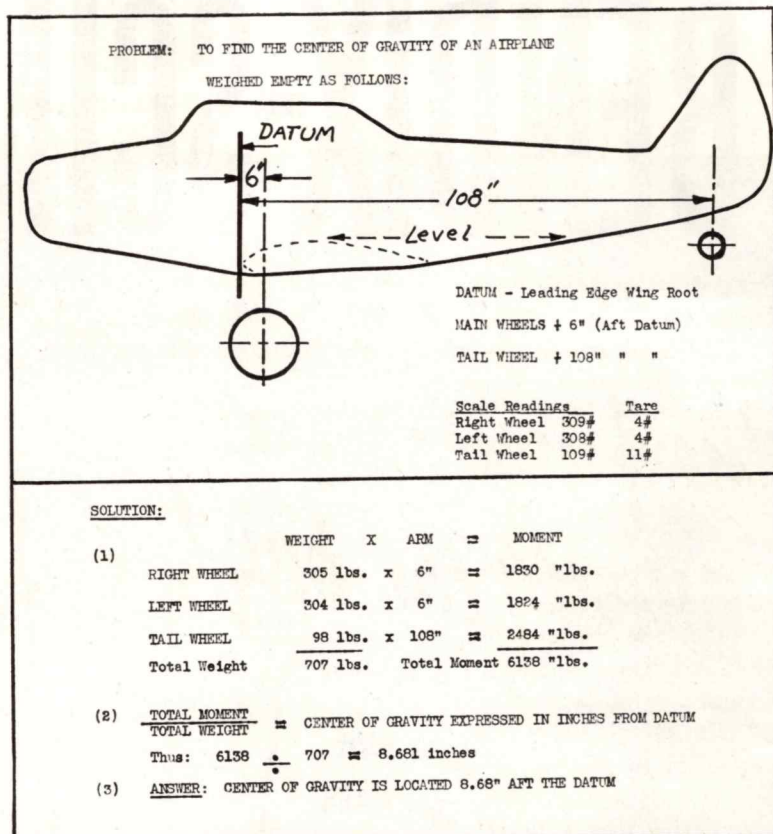


Figure 6

IF WAR TODAY

(Continued from page 16)

with any certainty, when or if Russia has the bomb, or in sufficient numbers to make the venture of war worth while. It seems reasonable to assume that when Russia has the A-bomb it will not hesitate to use it in one-way bombing missions against the industrial heart of the United States—or that we will hesitate to use it against Russian industry. In fact, the only uncertainties appear to be time and Russia's evaluation of her chances of success. However, as we already have the bomb, in numbers, the Russians should assume that our B-29's now based on the continent of Europe and in England are ready to deliver whatever we have available—even if they also have to do one-way bombing.

In recently published articles and statements by top-drawer Air Force spokesmen the emphasis always is placed upon the bomber—our own or the Russian version of the B-29—and its ability to fly to its target. The high losses of unescorted bombers over Germany in World War II seldom are mentioned, while the ability of the B-29 to bomb Japan is recalled without the qualifying statement that the B-29 hit Japan when Japanese air power was at its last gasp. If the B-29 had to bomb Russia tomorrow, no doubt it would encounter large numbers of defensive Russian fighters, both conventional-engined interceptors and jets. Does anyone believe that the B-29's successes over defenseless

Japan would be duplicated over Russia?

Even though some bombers always will get through—and given favorable bombing conditions of darkness and cloud-cover a satisfactory percentage of bombers may win through and return to their bases—it seems that the bomber of World War II is not a match for large numbers of defensive fighters and that the answer to enemy interceptors is not the bomber alone, but also its escorting fighters.

Many believe that the invention of the atom bomb is so revolutionary that it has shattered the age-old basic principles of warfare and that all war thinking before Hiroshima now is obsolete. The invention of the airplane also was thought—though not by many military men—to have altered war's first principles: that the primary objective of a military force is the defeat of the opposing military force.

That still is the primary objective of an air force, to win air supremacy—though it has been lost sight of and buried under the millions of tons of rubble of German and Japanese cities.

It was an Italian air strategist who in 1921 put the cart before the horse. According to General Giulio Douhet,

"the chief objective of an air force must be the destruction of the industrial heart of the enemy nation." "Wars," declared

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Douhet, "are fought by nations using the entirety of their resources—naval, military, industrial, and political. Without industrial support the actual fighting forces would be impotent; hence industrial centers are legitimate objects of attack. The only arm that will be able to move with the minimum of restriction is the Air Arm; this will be the only real offensive; the land and sea forces will be able only to resist."

So Douhet says: "We must group together all the forces of the nation in order to mass in that domain where the decision can be obtained—in the air."

The airplane, said Douhet, is an offensive, *not a defensive weapon*; so air power means hitting power, destruction power. It would be useless, he contended, to seek out the enemy's airplanes in the great expanses of the sky; it would be effective only to seek them out in their home grounds. It is effective to bombard industrial and political areas, and thus destroy in the mass of the population the will to wage war. Hence, to achieve this aim, *all aerial forces must be bombardment forces*.

Such, briefly, is the Douhet doctrine—which World War II proved fallacious. Douhet set down the new principle of air warfare as follows: "An Air Force should not concern itself with what the enemy may do, but only with causing that enemy the greatest possible damage on his own territory."

I encountered this doctrine early in 1936 in a U. S. Army Air Corps translation of Douhet's book. Here was a new air doctrine, declaring that the age-old principles of war would be overthrown—that the objective of an air force was civilian industry, *not the opposing military forces of the enemy*.

I entered into a lengthy correspondence with then Major, now General Claire Chennault, who declared flatly that anything that flies can be shot down by something else that flies—especially if it flies faster! Then I called on Brigadier-General Benny Foulois (retired), one of the first Army pilots and former Chief of the Air Corps. We spent a whole day discussing the new air doctrine that was to make all former war thinking obsolete—and we agreed that it did no such thing.

That was why, in March, 1936, in an article in *AERO DIGEST*, I pointed out the fallacies of the Douhet doctrine—in that civilian populations *undefended in the air*, would not long have the will to resist. If two nations resorted only to counter-bombardment the chief question to be decided, I said, would be which civilian population would give in first.

The air Battle of Britain and the air battles over Germany and over Pacific islands and Japan proved—and in three different theaters of war—that *the basic principles of war have remained unchanged throughout the centuries*. Strategic bombing, therefore, should not be considered the only objective of a properly conceived Air Force. The destruction of the enemy military force *in the air*—that is to say, of *defending* fighter planes and of *attacking* bombers—must be the initial aim of any air force that seeks to do strategic bombing. In actual warfare, of

course, the two may be achieved concurrently.

Two nations engaged in a war of counter-bombardment primarily should be fighting to achieve *command of the air*—to penetrate the air space above the enemy while denying such penetration to enemy bombers! If one nation achieves complete air mastery over the other, its air forces then may fly at will over enemy territory—subject only to the hazards of flak—and in time destroy everything that lies beneath. Hence, although defense alone never will win a war, it is a question which is the more vitally important, *the air offensive or the air defensive*.

Before the invention of radar, the advantage lay with the bomber. Without radar, it is probable that the British would have failed in their defensive air battles. Early warning radar, however, multiplied the power of the defensive many times by indicating where the raids were coming over and by directing the fighter pilots by radio, so that they lost no time in the air cruising around vainly looking until they ran out of fuel.

Even the B-29

The B-29 is not invulnerable; it can be shot down the same as any other airplane. It is not invisible; with radar it can be "seen" and followed and its course to and from its target can be determined and plotted with accuracy. And faster interceptors can be vectored to attack it.

We are building new and very fast jet bombers which may, and very probably will, revolutionize the tactics of strategic bombing. But in the problem discussed above we are not considering the use of those bombers, which as yet we have in only limited numbers. If they are used—and certainly they will be used to the limit of their numbers and as soon as they can be made operational—much of what I have discussed above will not apply. However, I am not discussing the kind of war we could wage with this amaz-

ingly fast equipment in 1950 or 1951. I am discussing only the bombers presently available *in quantity*, and suggesting the need for a reevaluation of the capabilities of the B-29 and the more powerful B-50 in the sharp light shed by that new advance in the air defensive—the jet fighter.

If Russia starts a war with us, it may reasonably be assumed that its high command believe they have enough defensive air power to retain command in their own skies while their huge army grinds its way over Europe. At the present time it seems clear that the only power we have to contain the Russians lies in what they think we may be able to accomplish with our air power. Certainly, air power is the only force with which either nation may come to vital grips with the other in its homeland.

Today all of the world's air forces are using equipment, most of which is obsolete from the standpoint of speed and range. But wars are fought not only with the most modern equipment; they are fought with whatever is available, at the start of the war.

If we have to fight Russia this year—say by next September, after the crops are harvested, the usual season for starting European wars—we may discover that the invention of the jet engine used in interceptor planes has made any figures of bomber losses based on our strategic bombing of Germany almost meaningless for this next war. The fact that we are getting jet-propelled bombers does not affect the doubtful situation of the B-29. If the Russians have studied the bomb damage in Germany and have formulated their war plans with that in mind, it would be reasonable to assume that they are building jet fighters as quickly and in as great numbers as they can manage—and probably much faster than we are.

Enough defensive fighters conceivably could stop cold a war of bombardment by rendering the losses so prohibitively high that we could not afford to continue.

FIGHTERS FOR THE FLATTOPS

(Continued from page 35)

In the jet, however, the pilot is afforded a nearly unrestricted view all the way in. When he takes a waveoff, the jet, although not accelerating as fast as the propeller plane, is entirely without the torque problem.

However, a hazard which cropped up by virtue of this same fine visibility put the pilot in an unprotected and dangerous position in the event the plane engaged the conventional barrier wires. This problem was solved by a special barrier developed for tricycle-gear propeller-driven fighters such as the Grumman F7F and Ryan FR airplanes. This is essentially a device that permits the barrier wire to lie flat on deck until the nose of the plane has passed. The barrier then springs up and engages.

Recently, at the Naval Air Test Center at Patuxent River, Maryland, experiments first with a dummy and then with a live subject, Lt. A. L. Hall, MSC, USN., were run to determine just how near a human can approach the suction intake of a jet plane without endangering himself. The plane used was the FJ-1 *Fury*, turning up at full power. Results showed that under normal

conditions a person can approach to within nearly two feet directly in front and a little less than two feet to either side of the nose with reasonable safety. Actually the jet intakes are less dangerous than propellers. Danger from the jet exhaust can be eliminated by thorough training of personnel to stand clear at all times.

The North American FJ-1 *Fury*, a stubby, rugged-looking low-wing airplane powered with a GE-Allison J35 jet engine, was the second Navy jet design to enter service. The *Fury* made its carrier debut in March 1948 with landings aboard the *USS Boxer*. Fighting Squadron 51, based at North Island, San Diego, California, equipped with the FJ-1 considers it one of the finest fighter airplanes in service use today.

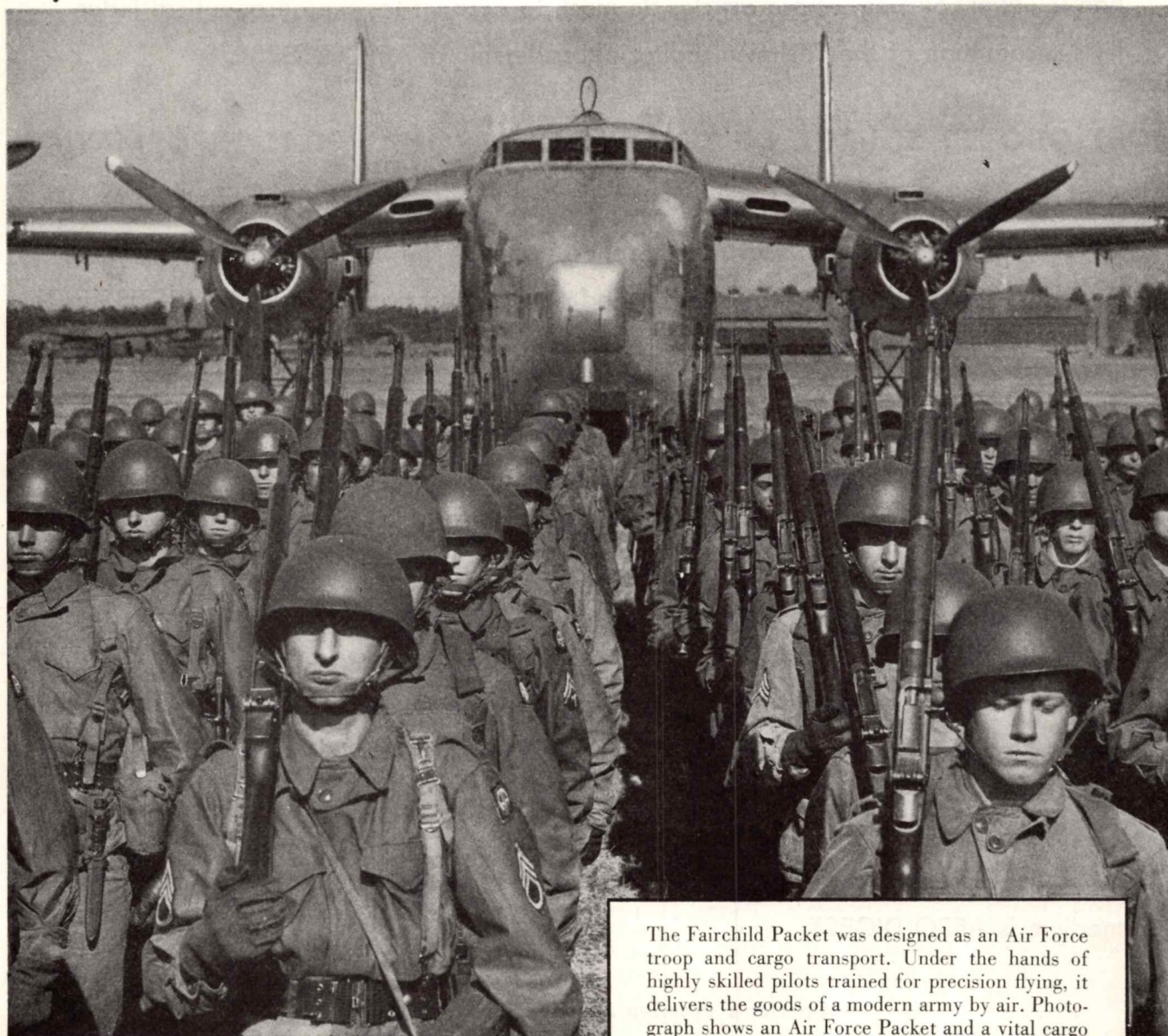
The McDonnell *Banshee* (F2H-1), developed from the *Phantom*, is now getting into quantity production—the first production airplane flew very successfully on 10 August 1948. This airplane, very similar in appearance to the *Phantom*, is larger and is powered by two Westinghouse J34 (24C)

(Continued on page 100)

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In 1947, and now again in 1948, TRANS WORLD AIRLINES has awarded first place in the Technical Writing Division of its Annual Writing and Photographic Competition to "Niel" Silsbee, whose articles do much to account for the aeronautical industry's recognition of the Technical Editorial Leadership of AERO DIGEST.

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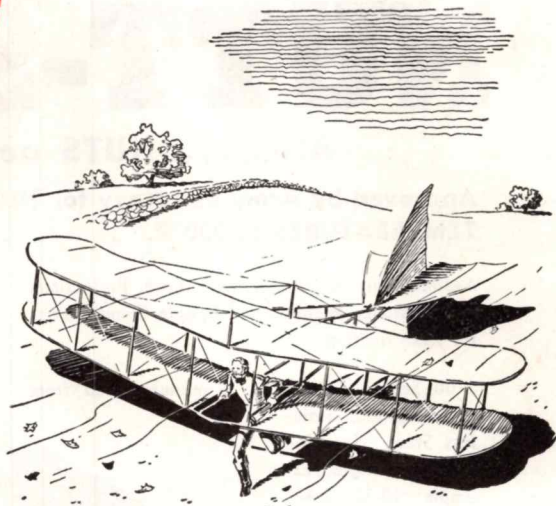
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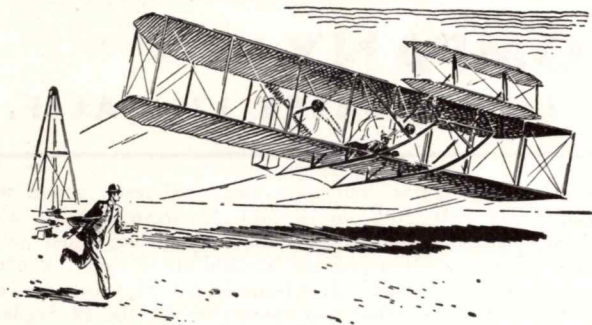
Who was First?



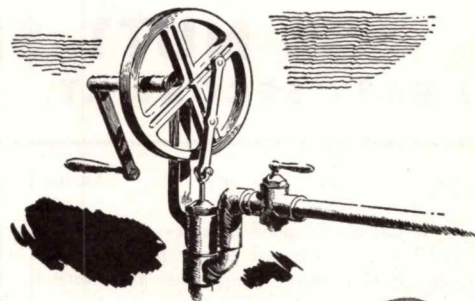
WHO WAS FIRST to apply the principles of the parachute conceived and sketched by Leonardo da Vinci in 1514? *Answer: In 1783 Lenormond jumped from the tower of the Montpellier Observatory holding in each hand an umbrella of 5 ft. diameter.*



WHO WAS FIRST to apply the principle of lift derived by driving an inclined surface horizontally through the air? *Answer: Sir George Cayley built the first successful man-carrying glider in England during the 19th century.*

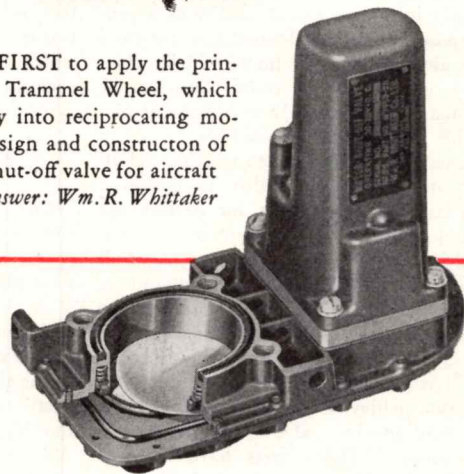


WHO WAS FIRST to apply the principles of air pressure to lateral control of powered aircraft? *Answer: The Wright Brothers developed the idea of lateral control through flexing wings and rudder manipulation in 1903.*



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(Continued from page 96)

jet engines. It has a top speed in excess of 600 mph and has demonstrated a very high rate of climb. It thus shows promise as an interceptor in addition to its utility as a general-purpose fighter. McDonnell has designed for this airplane wingtip tanks which, when installed, will extend its radius to where it will compare very favorably with those of piston-engine fighters now in service.

Grumman has demonstrated with the XF9F Panther its well-known ability to design a sturdy, fast fighter suitable for carrier use and comparable with the best of its contemporaries. The F9F, with its squared-off wingtips and "stepped" fuselage, presents a distinctive silhouette. Powered by either the Pratt and Whitney J42 Turbo-Wasp or the Allison J33, the Panther is in the 600-mph class. It is already well known for its short takeoff run, achieved in part by employment of a leading-edge slot nicknamed the "droop snoot." Flight tests have been so promising that the original production order has been increased.

The XF3D Skyknight, designed and built by Douglas Aircraft, is the Navy's outstanding entry in the night-fighter and all-weather field. This two-seater is equipped with elaborate and useful electronic equipment and promises to be a very versatile airplane. It has been in a flight status since March, 1948, with preliminary evaluation conducted by both the Navy and Air Force. Production commitments have been made to Douglas and "tooling up" has started. The XF3D has a twin powerplant similar to that of the F2H, Banshee, but with the jet engines

buried in the fuselage instead of in the wing roots as in the McDonnell designs. The F3D will be a night fighter designed completely as such, not a "conversion," and will embody every feature that the Navy's experience in this field has indicated desirable. A unique feature of the XF3D is the escape chute, which permits emergency egress from the cockpit through the bottom of the fuselage.

Use of the Afterburner

Chance Vought's entry in the jet field, the F6U-1 Pirate, is in initial production at the Stratford, Conn., plant. A small sleek job, it is particularly notable for its employment of a Solar Aircraft afterburner in addition to its single J34 powerplant. The afterburner is expected to give a substantial increase to the thrust of the basic engine and puts this small airplane abreast of the competitors in the high-speed and rapid-climb categories. Also notable in this design is Vought's employment of Metalite—a plywood aluminum-alloy combination which produces high rigidity and strength of external surface with the smoothest of finishes.

Still in the experimental stage is the Chance Vought XF7U-1, a radical airplane with a highly sweptback wing, which is now undergoing its test flights at the Naval Air Test Center, Patuxent River, Md., headquarters for Navy flight testing. This tail-less fighter will be powered by two Westinghouse J34 jets, augmented by afterburners.

Strictly for research purposes were developed the two Douglas planes, the D-558-1 and the D-558-2. With these two planes the Navy

has run many high-speed tests; and it was with the D-558-1 Skystreak that Lt. Col. Marion E. Carl, ace Marine fighter pilot, last year set a world speed record of 650.7 mph. The brilliant red Skystreak was designed and constructed by the El Segundo plant of Douglas for the National Advisory Committee for Aeronautics and the Navy's transonic research program. It is powered by a GE-Allison engine developed by the Air Force.

The D-558-2 Skyrocket is a jet-and-rocket improvement over the Skystreak. The sleek, needle-nosed, sweptwing Skyrocket is another plane designed strictly for research and, as was the Skystreak, is a joint undertaking of the Navy, the NACA and Douglas Aircraft. It is equipped to take off and land under its own power, with the rocket installation furnishing additional thrust in high-speed test runs. It is powered by Navy-developed J34 jet and RMI rocket engines.

All the new Navy jets in production incorporate cabin air conditioning, and pressurization, power jettison canopies and, of course, are designed to be equally at home aboard carriers or land bases. Ejection seats are specified as standard equipment in all single-seat fighters. In the field of jet powerplants, the Navy is using J33 and J42 centrifugal-type, J30, 34 and 35 axial-flow types, with single and twin-engine incorporation of afterburning.

Operating experience has proved that most of the fears regarding jet-airplane operation on carriers were groundless. Your Navy is proceeding as rapidly as possible to convert its carrier fighter squadrons, the first line of our Nation's airpower, to jet propulsion.

LEAR "OMNIMATIC"

(Continued from page 22)

When tuned to a runway localizer, the indicator shows whether the plane is on the blue or yellow side of the localizer. It is possible also to make an instrument landing using the localizer and communicate with the control tower, or receive GCA guidance, simultaneously. Voice can be heard on the localizer frequency while the visual indicator is being used.

Voice communication and range contacts are claimed to be reliable up to 100 miles. At 7000 ft. contacts of nearly 100 miles are said to be common and, with such a radius, a number of stations are available. Station interference and multiple bearing indications are eliminated by the high degree of selectivity of the VHF receiver. Accuracy is such that aircraft-position changes of one degree can be detected with a signal input of 10 microvolts.

Omnimatic is designed to "fail safe." No pattern appears on the scope unless a correct signal is being received. There is no possibility of an erroneous reading which might indicate a deviating flight path. If a range station becomes inoperative, if the tuning dial is moved accidentally or when an internal failure occurs, the scope produces no pattern whatsoever.

Operating controls are limited to volume and tuning knobs for the receiver and a six-position frequency selector and push-to-talk button for the transmitter. The hooded *Omniscope* has a "dim" control knob.

The "V"-type dipole antenna mounts at any convenient point on top of the plane. The receiver mounts in the glove compartment and the transmitter fits inside the same dust cover as the receiver, requiring no additional installation space. The *Omnipack* (scope amplifier and power pack) may be located remotely as convenient. The indicator scope is designed for mounting in one of the existing spaces for panel instruments. Remote-control units are available for the receiver and transmitter.

Crystals are furnished as standard transmitter equipment for 121.5 mc, 122.1 mc and 22.5 mc frequencies. They are available for frequencies of 122.3 mc, 122.7 mc and 122.9 mc. Current drain is 7 amps at 14 v and 3.5 amps at 28 v. Weight of the complete installation is approximately 24 lbs.

It is not necessary that the entire system be purchased at one time. The plane owner can begin with the VHF receiver—the basic unit—and purchase the remaining units progres-

SPECIFY **hi-g*** valves for aircraft

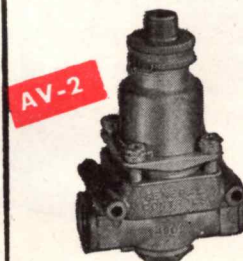
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3-way Electro-Magnetic valve used for distribution of fluid flow or for "feed in" and "exhausting" fluid from a cylinder, piston or vessel.



Same as AV-1 except is normally open type. For control of various fluids, oil, water, gasoline, air, etc.



Four-way selector type control—operating pressure up to 3000 P.S.I. for control of fluid pressure operated cylinders.



Electro-Magnetic valve for medium and high pressure applications. Controls hydraulic oils, fuels, lubricating oils, water, etc. 50 P.S.I. to 3000 P.S.I. operating pressure.



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Normally closed type Electro-Magnetic valve—for control of all types of fluid, gasoline, air, water, hydraulic fluids or oils, anti-icing fluids, etc.



Electro-Magnetic Double-Four Way selector type valve for control of fluid pressure operated cylinders.



Electro-Magnetic type valves with various magnet sizes, full ported or restricted ports, for all types of fluid, gasoline, air, water, oils, etc.

For complete specifications and engineering data, request new Catalog.

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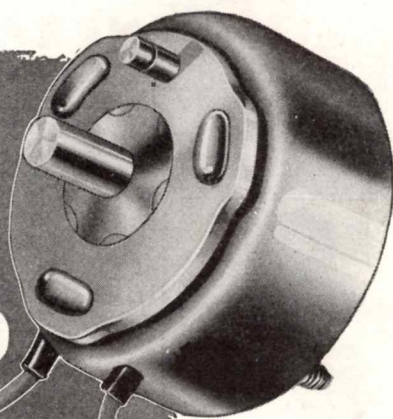


36-2

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... solves remote control problems

The many production uses of Leduc Rotary Solenoids vary from actuating bomb releases in military aircraft to controlling hydraulic valves in heavy duty industrial material handling equipment.

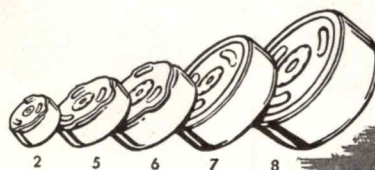
Five Leduc Rotary Solenoid models are manufactured. Diameters range from 1 1/8 to 3 3/8 inches. Predetermined rotation up to 95°, either right or left, can be engineered to suit your production requirements. Starting torques for 45° of rotation range from 1/4 to 50 pound-inches.

Precision manufacture to exacting specifications and individual operating tests are your assurance of dependable, long-life service under severe operating conditions.

Magnetic action moves the armature along the solenoid axis. This action is converted into a rotary motion by means of ball bearings on inclined races.



G. H. Leland INC.
DAYTON 2, OHIO



MODEL No.	2	5	6	7	8
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Torque Lb.-Inches	1/4	5	10	25	50
Weight Lbs.	1/8	1/2	1	2 1/4	4 1/4

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sively. The installed price of the receiver and transmitter will approximate \$400. For the full *Omnimatic* system it will be in the neighborhood of \$700.

AIRSHIPS IN THE NAVY

(Continued from page 27)

airplane arm of the Navy, and as unquestionably the most favorable operating spot in the San Francisco Bay area serves a wide variety of airplane uses. It is understood that airship facilities are being maintained at Moffett Field for possible future use.

Wartime necessity required a number of intervening and outlying simple mooring and servicing locations for airships, but today not a single one of them in the United States, in the Caribbean or elsewhere, is being maintained for airship use. Needless to say, this denies to peacetime airship operations the potential safeguard such "alternate" fields provide for emergencies or for expeditionary operations in their vicinities.

The senior officer in the naval airship organization bears the title of Chief of Naval Airship Training and Experimentation, with headquarters at NAS Lakehurst. Whereas this billet clearly warrants the rank of Rear Admiral, it was practically the only one in the whole naval aeronautical organization reduced to Captain following the war.

CNATE has a very small staff for directing airship training, experimentation and development, yet incongruously today this staff does not contain a single officer with aeronautical engineering qualifications (AEDO). CNATE is down on paper as the Airship Adviser to the Deputy Chief of Naval Operations for Air; but unless there has been quite a change since I held that billet, the principal activities of CNATE in this "advisory" capacity comprise trying to undo things already done to airships without his advice. Under CNATE, but operated by NAS Lakehurst, there are four airships for training and four for experimentation. The extremely small number of personnel assigned for these purposes clearly is one of the bottlenecks in airship development.

In the naval "forces in the field" (the Fleets) there is a so-called "Type Commander" for every class of naval craft, these type commanders being experienced specialists in their types. Our two airship squadrons are nominally included in the "Naval Aviation" branch of the Atlantic Fleet Organization, but there is no such thing as an Airship Type Commander, these airships being administered by officers not qualified to any degree therein.

In the Navy Department itself, there are only two billets that call for officers qualified in airships. One is in the Office of DCNO (Air), but so submerged in the HTA chain of command that the airship occupant has no authority whatsoever in airship matters and can only "recommend." The other Departmental LTA billet is a solitary engineering billet correspondingly submerged in the Bureau of Aeronautics. Though a tribute to the abilities of the airship officers involved, it is pure coincidence that a few other Departmental billets are currently being filled by airship men.

(Continued on page 104)

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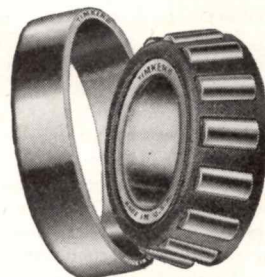
Wherever high precision is a factor, the new Timken "Double-Zero" bearing opens the way for improved product performance throughout industry. In machine tools, for example, the "Double-Zero" bearing will permit working to much closer tolerances than are now possible. In scientific instruments, the new Timken bearing will insure a new degree of precision that will raise the limits of accuracy in laboratories everywhere.

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Size range	Up to 10" O.D.	Up to 12" O.D.	Up to 12" O.D.

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Jacqueline Cochran embraces prop of her "Mustang." She holds speed records for three, 100- 1000- 2000-kilometer distances

(Continued from page 102)

The Navy justifiably speaks proudly of its Naval Air Reserve Training Program, which on June 30, 1948 included 54 carrier air groups, 50 multi-engined squadrons, and 47 aircraft supporting units, with 23 naval air-reserve activities maintaining over 2000 aircraft in operation throughout the country to provide facilities for these units. One of the most critical bottlenecks in the wartime expansion of airship operations was that of trained personnel.

Again today, as preceding World War II, the active airship organization in the regular Navy is unbelievably and unrealistically small. There are many World War II-trained airship personnel scattered around the country who could alleviate this shortage to some degree and who would gladly do so were they afforded reasonable opportunity to take Naval Reserve airship training and maintain such affiliations as is done on such a widespread basis in HTA. So let's see what effort is being made in this connection.

The One and Only

Based at NAS Lakehurst, we find the one solitary Naval Reserve airship unit in existence. This is Reserve Airship Squadron ZP-51 consisting of two airships. This two-ship unit of the Naval Aviation Reserve very commendably has attracted from all over the United States enthusiastic Airship Reserves whose continued enthusiasm and belief constitutes a real endorsement for airships.

Considerable lip service has been devoted to logical establishment of an Airship Reserve unit in Akron, Ohio, which was long the center of commercial airship interest in the United States. Yet, although an HTA Reserve unit has been established in Akron, there still is no such thing for LTA. On the Pacific Coast there are also many who would like to continue their affiliation with Naval airships through the medium of a Reserve airship unit more conveniently located for them than is Lakehurst, all the way across the continent. However, as one

of several questionable results of the abolition of airship operations in the Pacific, no Reserve airship squadron is found on that coast for the given reason that no supporting Regular naval airship operations are out there!

Whereas the staff of the Chief of Naval Reserve Aviation Training originally included the allowance of one Captain for LTA phases, even that has shrunk to one Lieutenant. Most commendably, Volunteer Aviation Units (LTA) have been formed at South Weymouth, Moffett Field and Los Angeles—and I do mean "volunteer," for these officers receive no training pay and these units have no official funds whatsoever to assist them.

As to the types of U. S. Navy airships, there are in existence four classes, most of them found in stowage crates. The small *L* and *G* classes, the former designed for commercial purposes years ago, constitute the Navy's training types. In the "patrol" classes, we find the *K* and the *M*. It was fortunate, despite almost complete neglect in the years between World Wars I and II, that on the eve of the latter the first *K* airship had proved itself as a flying vehicle although no armament or equipment had even been planned for it.

Of the larger, improved *M* class laid down during the war, only four were constructed, and their armament and equipment have never achieved final development. Despite this lack of prior development, our *WW II* patrol airships performed very valuable services within the opportunities afforded them. These types may conceivably warrant continuation in service indefinitely, though possibly in somewhat different roles despite the advent of newer designs.

Though several years late getting started, a contract has just been let for the design of a new prototype of the *N*-class which it is expected will incorporate wartime experience. Somewhat larger than any previous class, this new airship should produce considerably increased performance in various respects.

Some day, someone must take the naval airship program in hand on a realistic basis and do some "high-echelon" thinking on some of the basic problems, such as whether we are pursuing a correct pattern in even our current meager airship efforts. For example, even among airship personnel there is some question as to whether we are correct in trying to make of one type of airship

a jack-of-all-trades, or whether, in airships, too, we should not follow practice so prevalent in the airplane world, of building special types for special tasks.

Conceivably, the value of airships to the national defense might considerably be stepped up were we to develop two or possibly three types of airships. This is just one of various vital features that cannot be resolved properly under current integration of airships. Of not least importance, especially to the basic element of morale, is a conscientious solution of the problems of airship specialists who now find themselves the "misplaced" persons of the aeronautical world.

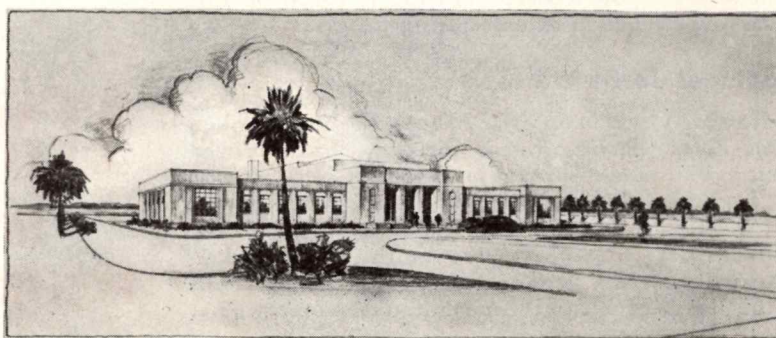
What does the future hold for airships? First of all, neither today's existing airships nor the *N*-type now on the drawing board, represent the maximum values inherent in airships, nor have we developed the optimum application of airships to naval problems. Given adequate opportunity, nonrigid airships can be developed to provide performance superior in every aspect to anything we have yet seen. This applies in design, materials, propulsion, and their auxiliary features of ground-handling and terminals.

Killed Aborning

Numerous war-inspired projects for airship improvements collapsed with the tumultuous release of so many fine technical and operating airship personnel trained during the war. Both personnel and budgetary limitations have impeded reactivation or seriously slowed down a number of these important projects, and, in present circumstances, the best we can hope is that wartime needs for airships will not materialize for a long time.

As but one illustration of a long overdue development here will soon be tested for the first time a "mechanical mule," an unbelievably flexible piece of machinery that will eventually substitute to a high degree for the various groups of men now employed in the ground-handling of airships, one of the most important remaining steps in the almost complete mechanization of airship ground-handling.

As to the "new look" in nonrigid airships, there will probably be no startling changes in exterior configurations for a while. Potentialities for further considerable improvement in the more or less conventional "fabric" airship do exist, but it is my feeling that, in time, the fabric airship will go



Sketch of \$165,000 headquarters being erected by the San Diego Section of the Institute of Aeronautical Sciences. Facilities will include auditorium, library, lecture room, stage, projection room, dining-room, kitchen and lounge

the way of the fabric airplane and be replaced by metal-hulled airships of considerably increased performance and effectiveness.

As for large or "rigid" airships, there are none in the Navy today; and space is not available herein for discussion of large airships, since this is intended as a review of the existing situation. However, let me say once more that, in my opinion, there are several important and completely justifiable uses for military airships of very large sizes. The old bugaboo of vulnerability is today minimized by such things as improved ordnance; the parasite jet-fighter plane, like that developed for the use of the B-36A bomber but applicable to the big airship also; by the generally accepted removal of guns from decks of submarines; and, as always, by common sense employment of airships.

Navy Stepchild

There is, however, no indication that the subject of large airships is being given even academic consideration by those who should be exploring every avenue of indicated assistance to the national defense. Some agency, and possibly it may have to be the Congress, will render worthwhile service to the country by resolving this unfortunate impasse.

Summing up the naval airship picture of today, all we have is an unrealistically small nonrigid-airship program of such restricted scope that even the slightest further reduction would reduce it to impotence. It is certainly of no credit to anyone that such a potentially useful type is still kept in the doldrums of indecision and misunderstanding. There is, however, a clear elemental solution of today's airship predicament. That is realization and recognition of the utterly simple fact that the airship is a "displacement aircraft" and not by any stretch of the imagination a member of the "winged-aircraft" family, fixed or rotary.

A hearty word of commendation is due the airship personnel of the Navy who, despite the artificial hazards administratively and otherwise dropped in their paths, continue such sincere efforts in developing the airship, the value of which to the national defense they alone seem to appreciate.

Yes, the authors of the Navy's 1948 Navy Day report were sounder than they probably knew in "including airships out" of "Naval Aviation." This omission spotlights the fact that the field of aeronautics embraces two distinct branches: "Aviation"—the art or science of flying in heavier-than-air machines; and "Aerostation"—the lighter-than-air counterpart. This fact should be honored by positive forthright implementation and not mere negative implication by omission. Looked at in track-sports terms, the airplane is the high-speed dash runner and the airship the slower distance runner. Yet, we seem to be insisting unrealistically that the long-legged airship must be entered only in the three-legged race hobbled to the totally different airplane.

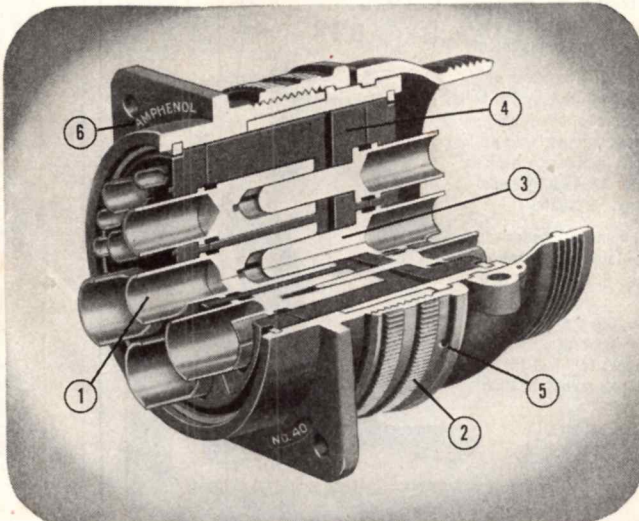
From another angle, corn and beans are important foods but we don't grow them in the same fields or package them together. Admitted or not, "Naval Aviation" still unrealistically mixes airplanes and airships. It is my opinion that naval air aspects of the national defense will thrive best on straight dishes rather than on aeronautical succotash.

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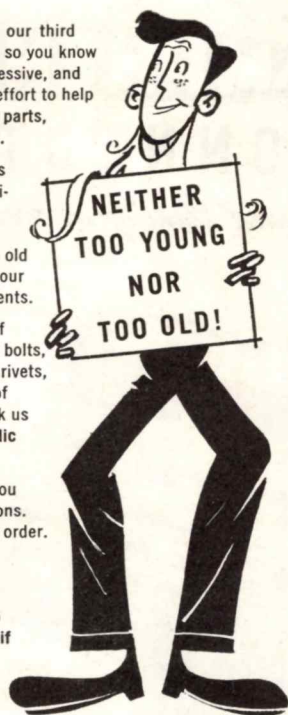
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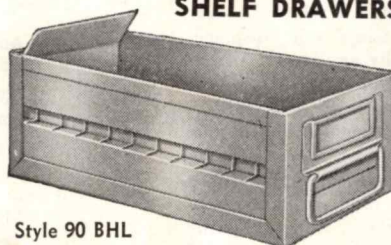
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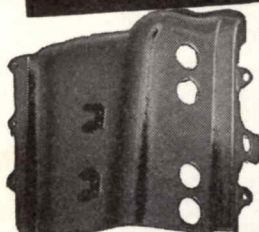
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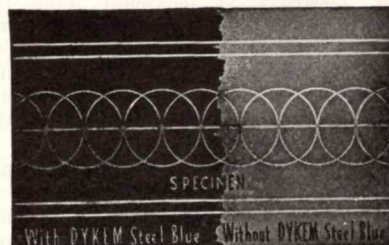


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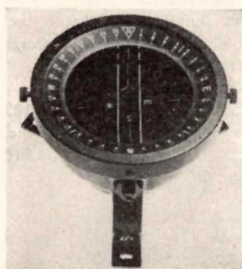
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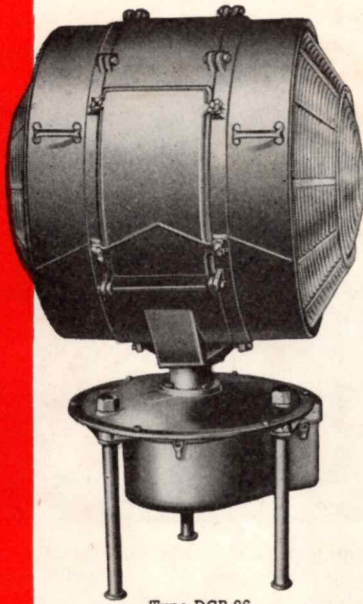
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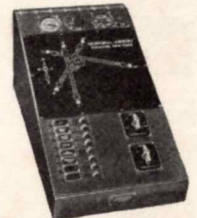


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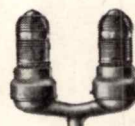
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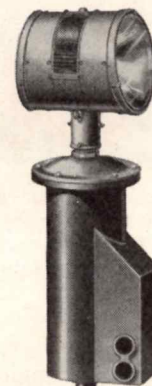
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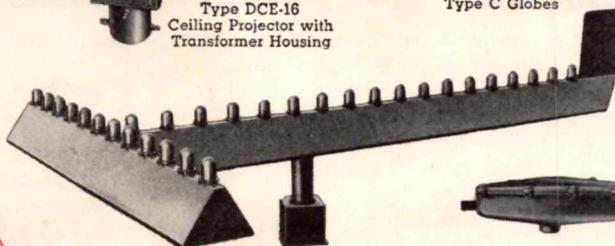
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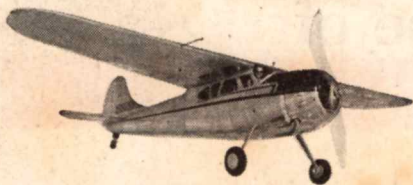


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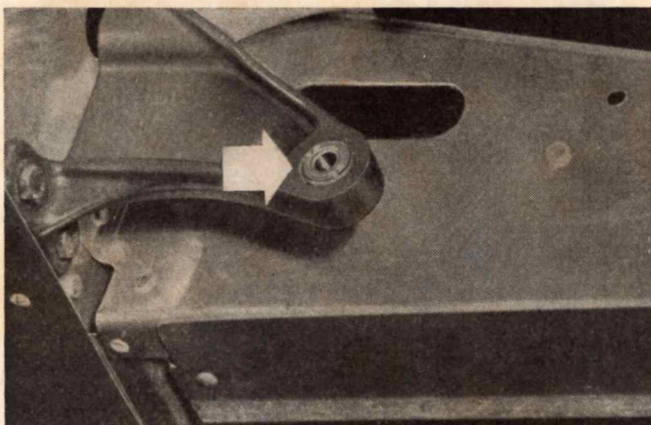
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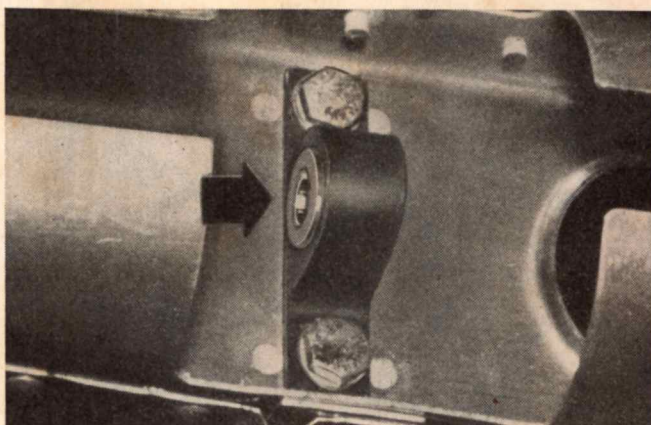


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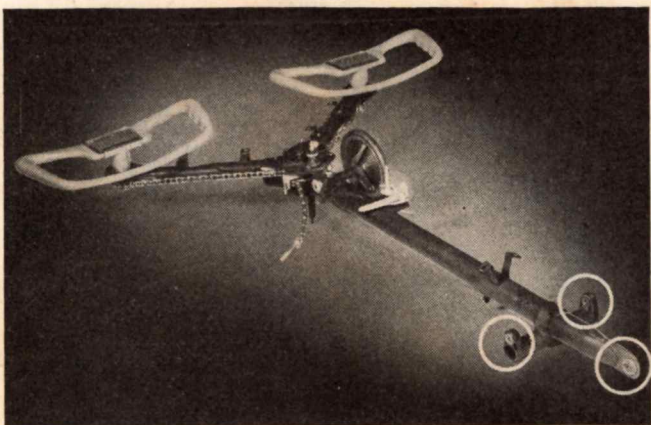
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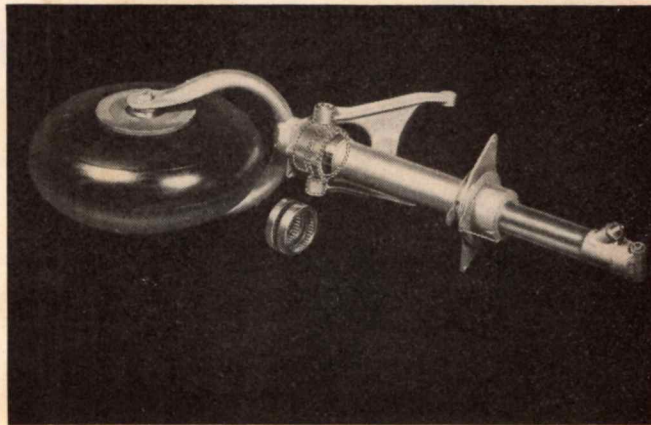
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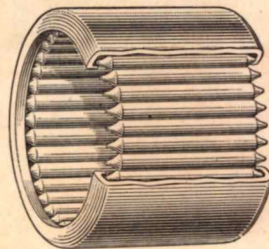


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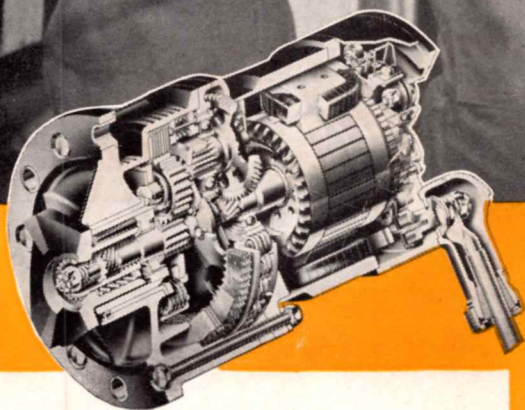
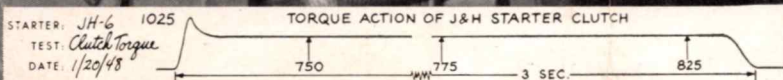
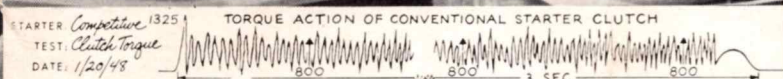


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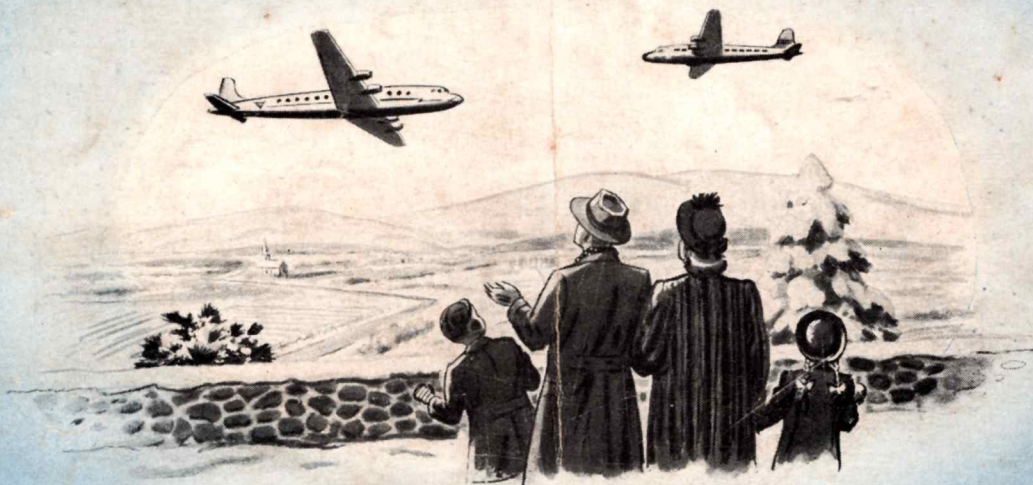
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